THE

AMERICAN NATURALIST

VOL. XXXII. *August, 1898.* NO. 380.

DENTITION OF DEVONIAN PTYCTODONTIDÆ.

C. R. EASTMAN.

(*Continued from page 488.*)

PALÆOMYLUS Woodward (1891).

This genus at present includes the forms described by Newberry as *Rhynchodus frangens* (the type species), *R. crassus*, and *R. greenei*, the first two being found in the Corniferous limestone of Ohio, and the last-named in the Hamilton of Wisconsin.

The special characteristics of this genus, as recognized by Woodward,[1] are as follows: it has a relatively very broad symphysial surface, a triturating oral surface, and a single indefinite tritoral area. From Ptyctodus it is distinguished by having punctate instead of laminated tritors, and the knife-edge of Rhynchodus is replaced in this genus by a broad, uneven, grinding surface. Yet the three types approximate one another through intimate specific gradations. For example, *R. secans* presents the same general form externally as Palæomylus, and between the lower dental plates of *Palæomylus crassus* and *Ptyctodus ferox* in the adult stage there is even greater resem-

[1] *Catalogue Fossil Fishes British Museum*, Pt. ii, p. 38. 1891.

blance. Thus, while there is a general homogeneity of type in Ptyctodont dentition, transitional stages are to be observed in its different expressions.

Palæomylus frangens and *P. crassus* are sufficiently well known through Newberry's figures and descriptions. With *P. greenei*, however, the case is not so fortunate. It has not been hitherto illustrated, and the original description is very brief. As stated by Newberry, it resembles the type species (*P. frangens*), but differs in being narrower vertically, and longer and much thicker at the anterior border. No distinctions are pointed out between upper and lower dental plates.

For further information with regard to *P. greenei* we have to thank Messrs. Teller and Monroe, of Milwaukee, who have kindly supplied all the material in their possession. Of this, the most remarkable specimen — and, we may safely say, one of the most important examples of Ptyctodont dentition yet discovered — is that photographed on the accompanying plate (Fig. 48). It is rivaled only by the specimen of *Rhynchodus secans* described by Newberry, already referred to, in which four teeth were found associated in a group; and the two taken together prove beyond a doubt that the dentition consisted of a single pair of dental plates in both upper and lower jaws. The present specimen was obtained by Mr. Teller in the vicinity of Milwaukee, and is preserved in his private collection.

The teeth are imbedded in a block of limestone measuring 35 cm. in its greatest length, which coincides with the longitudinal axis of the jaws. The illustration may be most conveniently examined by turning the page sideways, with the bottom on the left, and top on the right-hand side of the observer. Oriented in this position, the two lower dental plates will be found on the right-hand side of the figure, in advance of the upper pair; the left upper dental plate is immediately above the right upper, and the left lower above the right lower. All plates have the external surface exposed, with the exception of the right upper, which is broken through obliquely. The inner side is seen near the anterior beak, but farther back it is beveled down through its entire thickness, leaving only an impression of its outer surface on the matrix. Still it shows

the anterior margin and boundary of the triturating surface very fairly; much more so than its fellow, just above, which is the poorest preserved of all.

There is really less difference in the form of the lower dental

FIG. 48. — *Palæomylus greenei* Newb. Group of four naturally associated dental plates. Teeth of the lower jaw at top, and teeth of the upper jaw at bottom of the figure. Those belonging to the left side of the mouth are on the left, and those belonging to the right side are on the right of the figure. × ½.

plates than might be inferred from the photograph, owing to perspective effects due to the curved surface of the left lower

tooth. The outlines are preserved nearly intact as far as the extreme antero-superior portion, including the beaks, where there is a slight deficiency. The fracture being an uneven one at this point, and likely to present a misleading appearance, a strip was filled in with plaster up to a level with the external surface as far as the impression of bone substance was preserved on the underlying matrix, but no further. The original boundary was probably not far distant from the dotted line shown in the figure, which has been restored from the outlines of other specimens.

The differences between upper and lower dental plates are not nearly so decided as in either Ptyctodus or Rhynchodus, yet, such as they are, leave no reasonable doubt as to the position occupied by the several teeth in the mouth. The lower dental plates have a more pronounced anterior beak, and are also deeper vertically than the upper pair; and the triturating surface is more uneven. The outline of the latter is sinuous, there being an anterior and a posterior depression, separated by a median elevation ; and there are corresponding, although gentler, undulations to match in the margin of the upper dental plates. The opposing outlines coincide most nearly with one another when we make the upper beaks protrude slightly in advance of the lower, exactly as was done in the case of *Rhynchodus secans*. But there is no evidence that the beaks of the lower jaw closed outside the upper dental plates, as in Ptyctodus. On the contrary, appearances indicate that the two jaws came into direct opposition with their triturating surfaces, the same as molar teeth. There is a reverse slope to the grinding surface in both jaws ; the anterior depression has a decided slope downward and inward, and the posterior depression an equally pronounced one downward and outward. The grinding surface has an average width of about 1.5 cm., and extends from the beaks as far back as the supero-posterior angle, or where it meets the perfectly straight line forming the posterior margin.

There is a peculiar appearance about the beak of the left upper dental plate which deserves notice, although it challenges explanation. Owing to its faulty state of preservation, no very satisfactory conclusions can be formed as to its nature or

relationships, and the structure is all but obliterated in the half-tone reproduction. This much, however, we are warranted in saying: the extreme tip of the beak has been broken, and the bony substance about it extensively worn away, but traces remain of a thin bony splint or prolongation, somewhat triangular in outline, attached to, and extending in front of, the beak. The ossification is apparently continuous with that of the dental plate itself, yet has not nearly the thickness of the symphysial surface, being seemingly confined to the inner face thereof. Theoretical objections certainly will not allow us to conceive of the existence of an anterior azygous tooth, nothing of the sort being known to occur in this family; nor can the structure justly be called adventitious, since one of Mr. Monroe's specimens presents a similar, yet equally baffling appearance. The only plausible conjecture we can form regarding it is that, owing to the large size of the dental plates, some other besides merely cartilaginous means was required to strengthen their union at the symphysis, and this was supplied by an ossification arising from the inner side of the dental plates, forming a sort of bony suture. Mention is made of this anomaly in the hope that future discoveries may lead to its adequate explanation.

P. predator sp. nov. (Fig. 43). — The type specimen shown in the foregoing figure (p. 483) is unique. It forms a part of the Schultze Collection belonging to the Museum of Comparative Zoology, and was found in the Devonian limestone near Gerolstein, in the Eifel District. It is of no little interest to note that the three Ptyctodont genera, although represented by vicarious species, should thus occur together in homotaxial deposits of such widely separated regions as Central Europe and the Mississippi Valley.

Unfortunately, the present solitary specimen is not very well preserved, but still enough remains to show its general form and relationships. The part exposed to view is the anterior portion, happily with the beak intact, of the right lower dental plate. The inner surface is concealed by the matrix, and, being partly abraded, it is not easy to determine the original thickness of the tooth. Evidently the triturating surface was wide, rela-

tively, since it has a present width of 1 cm. as far as it is preserved back of the beak. The anterior margin is still about 1.5 cm. in thickness, but how much more has been abraded can only be surmised. This is enough, however, to show that the form does not belong to either Ptyctodus or Rhynchodus, although it resembles the latter in contour; hence, we have no recourse but to admit it as a new species of Palæomylus. The transition to Rhynchodus, brought about through thickening of the symphysial region and development of a broad triturating surface, evidently took place through the species described above as *R. major* and *R. rostratus*.

ASSOCIATED ICHTHYODORULITES.

Rohon,[1] in his paper on Ptyctodus, mentions the occurrence in the Russian Devonian of dorsal fin-spines belonging to the so-called "Chimæroid type of ichthyodorulites," as defined by Jaekel.[2] As no other form with which the remains can be theoretically associated is present in the same horizon, Rohon suggests that both dentition and defenses may have belonged to Ptyctodus. The Russian spines are bilaterally symmetrical, triangular in section, slightly curved backward, and are orna mented with numerous small tubercles, more or less regularly arranged. The posterior face is concave, and bears a double series of small denticles.

The style of ornamentation of these spines is remarkable, and we are at once struck with the coincidence that in the Hamilton limestone of Milwaukee ichthyodorulites should be found which have a similar tuberculated ornament. Several very choice examples have been obtained by Messrs. Teller and Monroe, one of the most perfect being that reproduced in Fig. 49, the property of Mr. Teller.

This spine has a very graceful curvature, and is of comparatively large size, the length of an arc joining the extremities

[1] Rohon, J. V. Beitrag zur Kenntnis der Gattung Ptyctodus, *Verhandl. mineral. Gesellsch. St. Petersburg*, vol. xxxiii, pp. 1–16, 1895.

[2] Jaekel, O. Ueber fossile Ichthyodoruliten, *Sitzungsber. Gesellsch. naturforsch. Freunde Berlin*, No. 7, p. 123, 1890.

on the anterior margin being 20 cm. The width where it is broken off below, which is not far distant from the beginning of the exserted portion, is 5.5 cm., and the maximum thickness at this point is 5.5 mm. The spine is extremely compressed laterally, both sides being almost flat. There is no strongly marked anterior keel. The posterior face is slightly sulcated, and each side of the sulcus is set with closely approximated tubercles of somewhat larger size than those occurring elsewhere. The bottom of the sulcus is traversed by a faint longitudinal ridge, triangular in section.

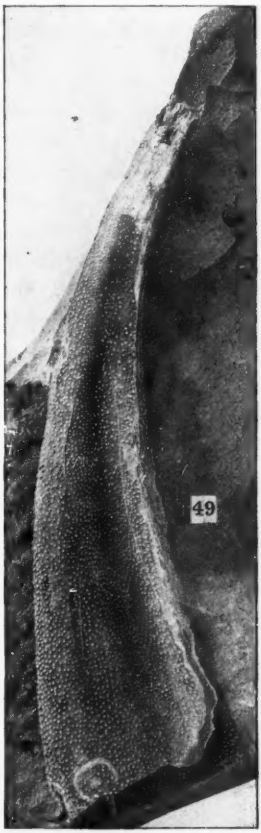

FIG. 49. — *Phlyctænacanthus telleri* sp. nov. Lateral aspect of exserted portion of spine (left face). × ⅔.

The individual stamp imparted to this spine by its flattened, arcuate shape is heightened by its peculiar ornamentation. The lateral faces are beset with numerous small tubercles not having a very definite arrangement, but in some specimens showing a tendency to become parallel to the anterior and posterior margins. One of Mr. Monroe's spines has the tubercles disposed more numerously along a series of parallel grooves, situated some distance apart, the whole presenting a more or less concentric appearance, and indicating successive growth stages in the development of the organ. The appearances indicate that the inserted portion tapered gradually toward the base, but this region itself has not been recognized on any of the specimens thus far examined. Most of the tubercles have been worn down smooth to their bases, or are evenly rounded on top, but a few retain traces of a fine original stellation. One or two spines, instead of

having the anterior margin uniformly curved, show a slight angulation at the region of maximum width, in that the spine tapers gradually from this point in both directions, distally and proximally.

Obviously these spines, differing as markedly as they do from the majority of Palæozoic ichthyodorulites, cannot be included under any known genus or species. We therefore propose the new genus *Phlyctænacanthus* for their reception, and have pleasure in naming the species *P. telleri* in honor of the veteran and indefatigable collector, Mr. Edgar E. Teller. Regarding their affinities, we can only suggest that they may have pertained to Palæomylus. Their large size precludes an association with either Rhynchodus or Ptyctodus; and Cladodus, the only other Elasmobranch known to occur in the Wisconsin Hamilton, was in all probability a spineless shark. On the supposition that these were the spines of *Ptyctodus ferox*, then we ought by good rights to have found similar fossils in the State Quarry fish bed, where there is such a wonderful concentration of Ptyctodus remains. But such spines as have been recovered from the Iowa locality are very different from *Phlyctænacanthus*. The latter are thus definitely excluded from all known genera occurring at Milwaukee, except Palæomylus. But as we know nothing, for instance, of the dentition with which *Heteracanthus politus* was associated, so, too, there is as much likelihood of *P. telleri* belonging to some unknown Elasmobranch genus as to Palæomylus. But as to the relative probability of one of these "genera" of Milwaukee ichthyodorulites belonging to the *Ptyctodontidæ*, the evidence of the tuberculated Russian fin-spines would go to show that *Phlyctænacanthus* is the likelier of the two to have its position established here.

(2) *Belemnacanthus giganteus* gen. et sp. nov. (Fig. 50). — This is the last form to claim our attention, and we notice it here more on account of its accompanying Ptyctodont remains in the Eifel Devonian than with the intention of suggesting possible Chimæroid affinities. In fact, we are inclined to suspect that it may have been of Ostracoderm rather than of Elasmobranch nature. But without entering into the question of its

systematic position further than this, we are content for the present with a portrayal of its general appearance, as shown in the adjoining views, supplemented by the following notes.

This unique and in many ways remarkable spine, which must be regarded as the type of a new species and genus, belongs to

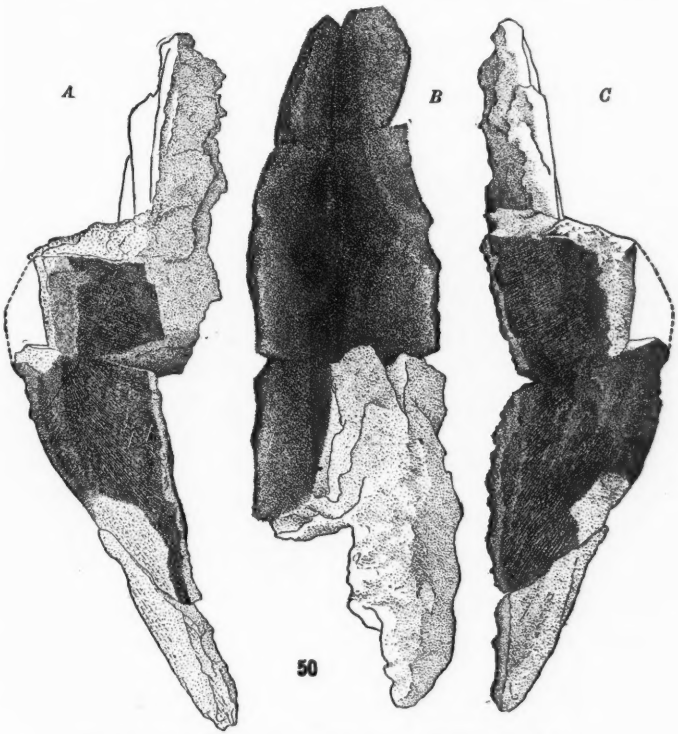

FIG. 50. — *Belemnacanthus giganteus* sp nov. *A*, *C*, lateral, and *B*, inferior aspects of spine. × ⅓.

the Schultze Collection, and was found in the Devonian, near Kerpen, in the Eifel District. It is extremely massive and even cumbersome, being solid throughout and of formidable proportions. The terminal portion of the spine is preserved for a distance of 27 cm., and the impression of it is continued for 10 cm. further, on an adherent piece of matrix. The section forms

an equilateral triangle, but the side corresponding to the posterior face in other forms is deeply excavated, the depth of the wedge-shaped cavity amounting to almost half the height of the triangle. In the view given of this side (Fig. 50, *B*), an attempt is made to show the change of slope and median groove at the bottom of the cavity. The surface of the latter is smooth throughout, and the appearances are unmistakable that it either contained soft parts or was attached to them during life. Such could hardly have been the case, however, if the spine stood erect and free from the body of the animal, but would necessarily happen were we to suppose it imbedded lengthwise in the flesh. That it actually was so imbedded appears the more probable when we consider the external aspect. Parallel markings are seen along the border on the lateral faces which apparently indicate the limits of integumentary covering; above these markings the sharp angle of the wedge protruded free as a cutwater, and probably served also as an offensive weapon; below them the bone sank beneath the skin, and was firmly secured by muscles attached to the channeled face. The latter, in the position suggested, would be *inferior* instead of posterior; the smaller, pointed end would be *posterior* instead of distal; and the larger, heavier end would be *anterior* instead of proximal or inserted.

Not only are the mechanical difficulties much lessened, of supporting free from the body an organ of such size and weight as this, according to the interpretation just outlined, but its plausibility is strengthened by the analogy of Edestus, with which it agrees in having no medullary canal. There is no doubt that the simpler types of Edestus (*E. heinrichsi*) were principally imbedded in the integument, so that only the row of denticles protruded. Bashford Dean,[1] in a very luminous paper on this genus, concludes as follows regarding the origin of the structure: "In the present case the evidence may be accepted as conclusive that a spine-like organ had its origin as a metameral structure whose basal portion lay within the integument, and traversed longitudinally a number (seven at least) of

[1] *Trans. N. Y. Acad. Sci.*, vol. xvi, p. 68, 1897. *Cf.* also *Fishes, Living and Fossil*, pp. 28–30, 1896.

body segments; and that from this condition arose a more or less typical spine shaft, thick at one end and pointed at the other, with indications that its decurved character was accompanied by a firmer insertion of the proximal end, and the evasion of a pointed tip." The stages of differentiation passed through by this genus are clearly depicted by Dr. Dean. We cannot well dissent from his view that the segmental structure observed in all species of Edestus is evidence of a primitive condition, and yet Belemnacanthus, a much earlier form, shows no trace of metamerism. Obviously, the two genera represent very different modes of origin of dermal spines. That either of them occupied a cephalic position, as suggested by Dr. Dean for Edestus, seems to the present writer improbable on account of their large size, a likelier position being somewhere along the middle of the back. Newberry's idea as to Edestus was that the spines were situated "in the position of the second dorsal fin on the back or tail of a Plagiostome fish."

The light-colored area at the posterior or pointed end of Belemnacanthus (Fig. 50, *A*, *C*) has been injured somewhat by atmospheric erosion, but still permits the course of the vascular canals to be seen. These run essentially parallel to the ornamental markings on the lateral faces, and prove that growth took place by additions to the posterior end. The markings referred to are in the nature of superficial pittings and furrows, the latter being sometimes continuous and bifurcating, or again short and interrupted. The dotted outline along the crest indicates the position of a thin piece of bone that, having been accidentally broken off from here, was used for sectioning. Nothing very conclusive was gained by this operation, however. The projecting portion of matrix at the top of Fig. 50, *A*, *C*, preserves an impression of the base of the spine as far as it extends. The lower margin being evenly arched throughout its extent of 37 cm., and the summit also as far as it is preserved, we note in this another point of resemblance to Edestus. In conclusion, it may be worth while to record that the largest Arthrodires yet obtained from the Eifel Devonian are *Aspidichthys ingens* v. Koenen; *Anomalichthys scaber* v. Koenen; and *Dinichthys eifeliensis* Kayser; and the largest Elasmobranch the

above-described *Palæomylus predator*. None of these are at all comparable, however, with the gigantic proportions indicated by Belemnacanthus.

ON THE RELATIONS OF THE DEVONIAN FISH-FAUNA OF MILWAUKEE.

Although fish remains are not at all plentiful near Milwaukee, yet the working of the Hydraulic Cement quarries within five miles of the city has enabled collectors to bring together a considerable variety of chordate fossils during the course of time. Only three forms from this locality were known to Newberry when writing his Monograph in 1889. These were *Rhynchodus excavatus*, *Palæomylus greenei*, and *Heteracanthus politus*. Besides the forms made known in the present paper, *Dinichthys pustulosus* was described last year from material that has long been preserved in the Museum of Comparative Zoology. In addition, a few unrecorded and several new species have been obtained by Messrs. Teller, Monroe, and Slocum, making a total representation of at least fifteen species. Among the new species are a tuberculated Titanichthys, plates of Sphenophorus which prove this little-known genus to be an Arthrodire, teeth of Cladodus with curved crown and strong lateral denticles, beautiful large scales of Holoptychius, and a number of dermal ossifications that are undoubtedly of Chimæroid nature. One of the latter bears some resemblance to Myriacanthus. Some detached Ptyctodus tritors are indistinguishable from *P. calceolus*, and one of the Heteracanthus spines seems to be identical with *H. uddeni* Lindahl.

Without question, the most interesting of all these remains, scientifically, is *Dinichthys pustulosus*. The meager material upon which it was founded is now increased by several more or less perfect crania, half a dozen dorso-median plates, the antero- and postero-dorso-laterals, the clavicular (which has the flat outer surface tuberculated), and one of the shear teeth. Unfortunately, the mandibles have thus far escaped detection. The writer's prediction, based upon the peculiar ornamentation of this species, that it would one day prove to be a very primitive

species of Dinichthys, is abundantly verified by the new discoveries, since a more ideal connecting link between Coccosteus and Dinichthys could hardly be imagined. Intermediate characters are most strikingly exemplified by the cranial sutures, sensory canals, and form of the dorso-median plate. A more detailed account of its organization will be presented later. Our purpose now is to call attention chiefly to the facts of its distribution, along with the accompanying Ptyctodont remains.

In the first place, we note that *Dinichthys pustulosus*, *Heteracanthus uddeni*, and probably *Ptyctodus calceolus* all occur together in the Hamilton of Milwaukee, the State Quarry fish-bed of Johnson County, Iowa, and in the vicinity of Buffalo, Iowa, and Rock Island, Illinois. The Rock Island section has lately been worked up in considerable detail by J. A. Udden,[1] who distinguishes thirteen different beds. Beds Nos. 2, 3, and 4, of his published section, contain the assemblage of fish remains now under discussion, but Ptyctodus also extends upward into Nos. 5 and 9. No. 2 corresponds to the Gyroceras beds of Calvin and Barris, No. 3 to the lower part of the Cedar Valley limestone, and No. 4 to its upper part. Professor Udden has traced out the subdivisions of the fish-bearing beds with great care, and has very kindly submitted the following table for publication at the writer's request, by means of which any one can readily orient himself when collecting in the field.

DESCRIPTIVE TABLE OF PART OF THE SECTION OF DEVONIAN ROCKS EXPOSED NEAR ROCK ISLAND, ILLINOIS.

No. 4 (= UPPER PART OF CEDAR VALLEY LIMESTONE).	(*b*) A slightly argillaceous bluish limestone filled with fragments of Crinoid stems, locally changing into a white compact limestone, from 6 to 10 feet in thickness. *Megistocrinus latus* Hall and *Striatopora rugosa* Hall almost invariably occur near the base of this division. Transition to the coral-bearing beds above always abrupt and conspicuous. (*a*) An argillaceous bluish limestone weathering to a dirty yellow. Thickness from 15 to perhaps over 20 feet. Principal fossils are: *Aulopora* sp.; *Monticulipora* sp.; *Streptelasma rectum* Hall; *Atrypa aspera* Schloth.; *Spirifer pennatus* Hall; *S. asper* Hall; *Chonetes pusillum* Hall; *Strophodonta demissa* Conrad; *S. perplana* Conrad; *Orthis iowensis* Hall; *Cyrtina hamiltonensis* Hall; *Goniatites* sp.; *Phacops* sp.; *Heteracanthus uddeni* Lindahl; *Dinichthys* fragments.

[1] *Journ. Cincinnati Soc. Nat. Hist.*, vol. xix, No. 3, pp. 93–95, 1897.

No. 3 (= LOWER PART OF CEDAR VALLEY LIMESTONE).

(*f*) A layer of calcareous shale or clay, 6 inches thick, containing mostly Brachiopods and Bryozoa.

(*e*) A bed of olive-colored limestone, 2 feet in thickness, rich in fossils, especially Brachiopods, such as *Spirifer pennatus* H.; *S. asper* H.; *Chonetes pusillum* H.; *Strophodonta demissa* Conr.; *S. perplana* Conr.; *Discina* sp. A branching *Monticulipora* generally present about the middle of this bed.

(*d*) A layer of greenish calcareous shale, 6 inches thick, with fossils like those in the ledge below. *Strophodonta perplana* Conr. more abundant.

(*c*) A ledge of limestone, about 16 inches in thickness, of a dull dove color, fine and massive below, almost a shell breccia above. Rich in Brachiopods, such as *Spirifer asper* H.; *S. pennatus* H.; *Atrypa aspera* S.; *Orthis iowensis* H.; *O. vanuxemi* H.; *O. suborbicularis* H.; *Strophodonta demissa* Conr.; *S. perplana* Conr.; *S. nacrea* H.; and *Chonetes pusillum* H.

(*b*) A layer of greenish calcareous shale, 6 inches in thickness, containing mostly Brachiopods like those above.

(*a*) A bed of limestone, 2 feet thick, consisting below of a gray compact rock not dissimilar from No. 2 (*d*); above, it becomes slightly laminated and more fossiliferous. Brachiopods predominate above, corals below. A seam in which fossils are etched and partially dissolved separates this bed from the ledge beneath.

No. 2 (= GYROCERAS BEDS OF CALVIN).

(*d*) A ledge of limestone, about 2 feet thick, gray, compact, and strong, the upper part often marked with yellowish or brownish blotches. Principal fossils are: *Stromatopora* sp.; *Favosites alpenensis* Winch.; *F. placenta* Rom.; *Acervularia davidsoni* E. and H.; *Phillipsastræa gigas* Owen; *Crepidophyllum archiaci* Bill.; *Cystiphyllum americanum* E. and H.; *C. sulcatum* Bill.; *Atrypa aspera* S.; and *Spirifer*. Also *Dinichthys pustulosus* Eastm. and *Ptyctodus calceolus* N. and W.

(*c*) A thin layer of limestone, only a few inches in thickness, not always separated from the next above; frequently containing thin seams of clay. *Phillipsastræa* and *Stromatopora* are quite abundant.

(*b*) A ledge of gray compact limestone, about 3 feet thick, invariably containing *Phillipsastræa* and *Crepidophyllum* near the top. Besides having most of the fossils found in the ledge below, it contains: *Chonophyllum* sp.; two or three species of *Cystiphyllum;* one of *Alveolites* of fine, dense structure and spheroidal form; several species of Gastropods and Trilobites; *Phragmoceras;* and *Ptyctodus* tritors.

(*a*) A ledge about 2 feet thick, consisting of a strong, finely granular, and compact gray limestone, with a slight tinge of dusky straw color, occasionally divided by two seams near the middle. Principal fossils are: several species of *Favosites*, *Acervularia*, and other Cyathophylloids; *Stromatopora; Spirifer subundifera* M. and W.; *Atrypa reticularis* L. (often with well-preserved spiralia).

From the above it will be seen that the pisciferous beds near Rock Island lie within the equivalent of the Cedar Valley

limestone, with Ptyctodus extending both above and below this level. The State Quarry fish-bed is held by Professor Calvin [1] to represent a later horizon than the Cedar Valley limestone, its anomalous relations leading him to the conclusion "that it was deposited unconformably upon the Cedar Valley limestone after the lapse of a considerable erosion period." The evidence of invertebrate remains indicates that "the relations of the State Quarry limestone are with the Upper and not with the Middle Devonian, as is the case with the Cedar Valley beds." Certainly the vertebrate fauna occurring here is unparalleled elsewhere in the Devonian, but in the assemblage we note the same species of Ptyctodus and Dinichthys as are found at Milwaukee and Rock Island, and probably also Heteracanthus.

Where, now, shall the Milwaukee horizon be placed in the series? The strata here are divisible into two formations, the lowermost being the fish-bearing cement rock, and the uppermost a soft shale apparently destitute of vertebrate remains. Dr. Stuart Weller,[2] who has made a study of the invertebrates, finds that those from the lower formation are apparently most closely related to the typical eastern Hamilton fauna, as represented in New York state, although there are a few forms which seem to represent the Iowa faunas. The upper formation has an abundant and well-preserved fauna, very different from that below. It is not the New York Hamilton fauna, but appears to be intimately related to some of the Iowa Devonian assemblages. With these generalizations vertebrate evidence stands in substantial agreement. Through Rhynchodus, Palæomylus, and primitive Dinichthyids, the hydraulic limestone fauna is related to that of the eastern province, dating back even to the Corniferous of Ohio. The Chimæroids give it a stamp of antiquity, suggesting that a westward migration took place during the early part of the Devonian as far as Wisconsin, but not crossing the Mississippi Valley until the Middle Devonian. The Milwaukee beds show the first traces of encroachment from the east, the Rock Island locality a somewhat later, and the State Quarry limestone the last of all, with its horde of Upper

[1] *Ann. Rep. Iowa Geol. Survey*, vol. vii, pp. 78, 79, 1897.
[2] *Ann. N. Y. Acad. Sci.*, vol. xi, p. 117, 1898.

Devonian lung-fishes. By this time the gigantic Chimæroids (Palæomylus, *Ptyctodus ferox*, Phlyctænacanthus, etc.) had disappeared; the ubiquitous *Ptyctodus calceolus*, it is true, persisted for a while through sheer force of numbers, but after the State Quarry epoch is met with no more. Cladodonts seem to have had a continuous existence throughout this period, appearing first in the Lower Devonian of Campbellton, New Brunswick (Protodus, Doliodus, etc.), but they do not appear to have migrated west of Wisconsin until the Carboniferous. They did not fairly enjoy their ascendency until after the lung-fishes had suffered a decline.

THE WINGS OF INSECTS.

J. H. COMSTOCK AND J. G. NEEDHAM.

CHAPTER III (*Concluded*).

XII. THE VENATION OF THE WINGS OF COLEOPTERA.

The determination of the homology of the wing-veins of the Coleoptera is a difficult problem, owing to the greatly modified structure of the wings. Not only do the wings differ in structure from those of any other order of insects, but the two pairs of wings are modified in different ways. The fore wings, or elytra, have lost their flight-function, and have become thickened protective organs; while the hind wings are, in most cases, transversely folded, which has resulted in a great modification of the courses of the veins and in the formation of secondary vein-like thickenings of the wing.

So different is the structure of the elytra from that usually characteristic of wings that Meinert[1] was led to believe that they were not wings, but greatly enlarged paraptera of the mesothorax; and unfortunately this view was adopted by the senior writer in his *Manual for the Study of Insects*. We have, therefore, two questions before us: first, Are the elytra modified wings, or not? and, second, What are the homologies of the wing-veins?

The reasons in support of Meinert's view are the following: the difference in the structure of elytra from that of wings; the fact that in the Lepidoptera the paraptera of the mesothorax often bear a striking resemblance to elytra (this can be well seen by removing the scales from the paraptera, or patagia, as they are termed, of a sphinx moth); and the fact that in many Coleoptera (*e.g.*, *Dytiscus*) what appear to be rudiments of the fore wings exist beneath the elytra.

The argument based on the thickened structure of the elytra loses its force when we consider the more or less elytra-like

[1] Meinert, F. *Entomologisk Tidskrift*, p. 168. 1880.

wings of many other insects (Heteroptera, certain Blattidæ, *et al.*); and it probably would not have been seriously urged but for the presence of the so-called rudimentary wings beneath the elytra of certain beetles.

When, however, the supposed rudimentary wings are examined, they are found to correspond in structure and position to the alulæ of the wings of other insects. The most conclusive evidence of this correspondence is the fact that they are margined by the cord-like structure which has been termed the

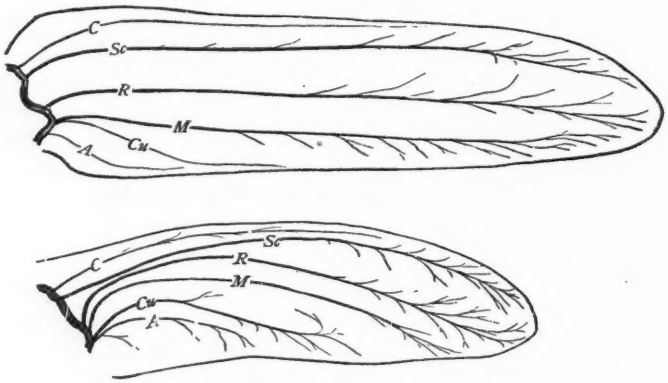

FIG. 50. — The tracheation of the wings of a cerambycid pupa.

spring-vein. This arises from the caudal border of the scutellum, and is a distinctive characteristic of this portion of the wing. The presence of these membranes beneath the elytra, therefore, merely indicates that if the elytra are modified wings they do not correspond to entire wings but to wings minus the alulæ.

When the elytra of a pupa of a beetle are examined, they are found to be traversed by several, usually five or six, longitudinal tracheæ. Although these tracheæ may give rise to a greater or less number of smaller tracheæ, there is nothing in the branching of them, in any of the forms that have as yet fallen under our observation, that corresponds with the branching of the tracheæ in our hypothetical type. But as this is almost as true of the hind wings, it has little bearing on the question of

the homology of the elytra. We are forced to conclude that in this order the wings are so modified that the typical branching of the veins is lost. We have examined, however, a comparatively small series of coleopterous pupæ; and it is quite possible that generalized forms may yet be found in which the typical branching of the veins is preserved.

We refer to the veins instead of to the tracheæ in this connection, as some observations that we have made indicate that in the Coleoptera as in the Hymenoptera the venation of the

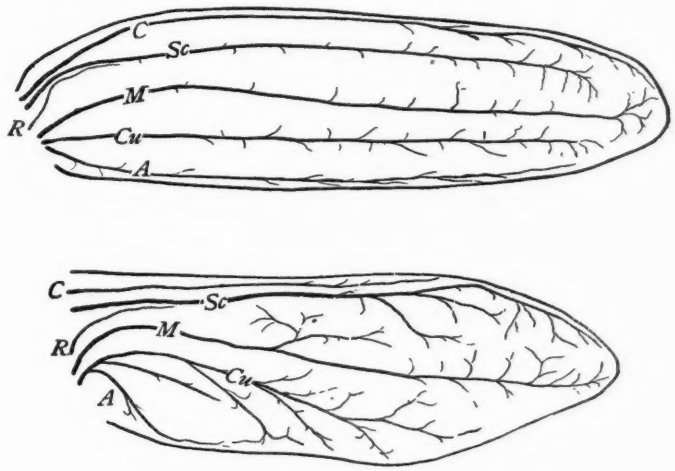

FIG. 51. — The tracheation of the wings of a cerambycid pupa.

wings precede their tracheation, and that the courses of the main tracheæ are determined by the courses of the preëxisting veins.

Returning to the question of the homology of the elytra, the most conclusive evidence that we have found is the fact that a very close correspondence exists between the tracheation of the elytra and that of the hind wings. And what is especially striking is that similar modifications occur in the two pairs of organs.

The accompanying figures of the elytra and wings of two cerambycid pupæ illustrate this point. And the lettering of

these figures will serve to show our conclusions regarding the homologies of the tracheæ.

In the species represented by Fig. 50, the radial trachea is the most prominent one in both elytra and hind wings. On the other hand, in the species represented by Fig. 51, the radial trachea is reduced in both elytra and hind wings to a mere rudiment. If the elytra and hind wings were not homodynamous organs, it is not probable that the modifications of the two would be so closely correlated. We conclude, therefore, that the elytra are modified wings.

In comparing the tracheation of the elytra with that of the hind wings, the most striking difference observed is the greater

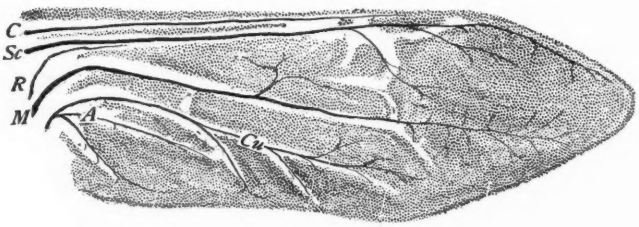

FIG. 52. — Hind wing of a pupa of a beetle.

reduction of the anal area of the former. This is doubtless due to the fact that the meeting of the elytra when at rest in a straight line along the middle of the back does not admit of an expanded anal area.

The extent of the correspondence between the venation and the tracheation of the hind wing of a full-grown pupa is shown by Fig. 52. The principal tracheæ are within the veins, but the branches of these tracheæ extend irregularly through the wing. In the region where the wing is to be folded the secondary vein-like thickenings are only partially supplied with tracheæ.

Although the veins of elytra of adult beetles appear in many cases as well-marked ridges, when elytra of pupæ are prepared, as we prepare wings for this purpose, and examined by transmitted light, we do not find any difference in color between the forming veins and the spaces between them.

With this we conclude our discussion of the venation of the series of forms illustrating the specialization of wings by reduction. The sequence in which the forms have been discussed has been determined merely by convenience, except that we believe that the Plecoptera, which were treated first, resemble the primitive winged insect in the tracheation of their wings more closely than do the members of any other order as a whole. In the next chapter we will give some illustrations of the specialization of wings by addition.

ENTOMOLOGICAL LABORATORY,
CORNELL UNIVERSITY, May, 1898.

ON THE ALTERNATION OF SEX IN A BROOD OF YOUNG SPARROW HAWKS.

DR. R. W. SHUFELDT, C.M.Z.S.

IN the early part of May (1898) a collector sent me a brood of five nestling sparrow hawks (*Falco sparverius*), taken from their nest in the neighborhood of Washington, D. C. At the time of reception they were in excellent health and vigor, and all readily fed from the hand bits of raw beef that were offered to them. The quantity of such food each one could eat at a single meal, and the rapidity with which it was digested, were both remarkable facts. A pound and a half of beef was equally divided among them within a quarter of an hour, and was disposed of without any apparent inconvenience to them. Having kept them five or six days in a small basket in which an improvised nest had been made, it was noted with surprise that this temporary habitation remained unsoiled by their excrement, which, however, was by no means the case with the floor for nearly a yard from the edge of the basket, and upon the walls of the corner of the room where the basket was kept, up for nearly an equal distance. In this particular, nestling raptorial birds are at marked variance with such groups as the Passeres and the Woodpeckers, for example, where the parents habitually carry away the excrement of their young, and drop it at a distance from the nest. On or about the sixth day I made a series of photographs of these young hawks, taking them singly, and in one instance two of them together, after which my son chloroformed the five and made a very excellent series of skins of them. Upon dissection and a study of this series a number of interesting points were brought to light. It was noted in the first place that the largest bird of the brood, and of course the oldest one, was nearly double the size of the youngest or last one of the series, while the three others graduated down, from the largest to the

smallest, in almost exact proportions. It was evident, then, that the female had laid the eggs at regular intervals, and very likely three or four days apart, and that incubation commenced immediately after the first egg was deposited. What is more worthy of note, however, is the fact that the sexes of these nestlings

Nestling sparrow hawks. One-half natural size.

alternated, the oldest bird being a male, the next a female, followed by another male, and so on; the last or youngest one of all five being a male. This last had a plumage of pure white down, with the pinfeathers of the primaries and secondaries of the wings, as well as the rectrices of the tail, just beginning to open at their extremities. From this stage gradual development of the plumage is exhibited throughout the series, the entire plumage of the males and the females being very different and

distinctive. It would be interesting to ascertain if this is always the case among the *Falconidæ*, or was only accidental in the present instance. Prof. Alfred Newton, in his *Dictionary of Birds*, page 634, says that owls often begin brooding as soon as the first egg is laid; "but, if my observation is not mistaken, the habit is not constant, even with the same individual bird"; and he adds, by way of explanation, that this "practice unquestionably has its advantages, since the offspring, being of different ages, thereby become less of a burden on the parents which have to minister to their wants, while the fostering warmth of the earlier chicks can hardly fail to aid the development of those which are unhatched, during the absence of father and mother in search of food; but most birds, and, it need scarcely be said, all those the young of which run from their birth, await the completion of the clutch before sitting is begun."

Bendire, in his account of this falcon in his *Life Histories of North American Birds*, says positively that the eggs "are deposited at intervals of a day," but he has nothing to say about the alternation of the sexes in the brood. It is a well-known fact that the eggs of the sparrow hawk vary greatly in form as well as in their ground color and markings. As to this last, it may largely depend, as I have pointed out in my *Comparative Oölogy of North American Birds*, "upon the physical condition of the parent bird at the time of depositing the egg." [1]

If it be true that the sexes alternate in broods of young sparrow hawks, as a regular thing, the present writer has no explanation for the fact, nor has he ever heard of one as having been advanced by any other observer, and it is more than probable that it will be a long time before science will be in possession of the correct interpretation.

In the reproduction of my photograph illustrating this paper, both the birds in the picture are *females*, they being the oldest and the youngest of that sex of the five; in other words, they represent birds numbers two and four of the brood. In order to photograph them I was obliged to build up the little platform of twigs, seen in the figure, for them to rest upon, as

[1] *Report of U. S. National Museum*, p. 476, 1892. This memoir is now entirely out of print.

neither of them could steady itself by holding on to a small branch, — at least, the younger one could not, and its sister could do so only for a short time, — while the oldest bird of this brood could perch well. Sparrow hawks usually build their nests in the hollows of old trees, but occasionally they utilize the abandoned nests of other species.

"NOXIOUS" OR "BENEFICIAL"? FALSE PREMISES IN ECONOMIC ZOÖLOGY.

SAMUEL N. RHOADS.

So many thousands of American dollars have been spent in the last ten years upon the investigations of the United States Department of Agriculture into the economic relations of plants and animals to man, and so much of inestimable value has been accomplished in this direction, that any criticism of the work turned out may seem captious, so greatly does the good outweigh the bad in the gross account. Nevertheless, there is always a disaffected portion of the agricultural classes who sneer at the study of "bugs and bird stomachs" as a most unhappy and worthless waste of taxes. It is too true that the horse sense and field experience of some of these country folk often has a deeper and more practical wisdom in it than the professional zoölogist or botanist can gain in his laboratory work. Even the specialist in some of these studies would fain join in with the cry of the farmer that all our efforts to regulate the ravages of noxious animals and plants are as likely to increase or transform the evil as to correct it. Under former conditions of ignorance there was abundant cause to advocate such a happy-go-lucky theory, but now, thanks be to the persevering efforts of true science and wise legislation, we must all agree that it is our duty to spend and be spent in these researches.

It has been the writer's privilege to belong to both classes in this friendly controversy, and, with a fellow-feeling and sincere respect for each of these, he believes that the following remarks will be taken as evidence of his desire to reconcile and not antagonize the truth-seeking patrons and disciples of husbandry, whether in the field or the laboratory.

It will best subserve the object of this essay to use *Bulletin No. 3* of the United States Department of Agriculture on the "Hawks and Owls of the United States in their Relation to

Agriculture" as representing in one volume the standards by which the economic value of most of the mammals, birds, insects, and reptiles coming under the special notice of the Department have been estimated. It may be added that all subsequent publications of the Department indicate that there has been little change in these standards since the issue of the above-mentioned work of Dr. A. K. Fisher. Published in 1893, this well-prepared and finely illustrated little book represents the highest attainment in the development of economic ornithology yet reached in this country or abroad. Dr. C. Hart Merriam, under whose supervision the work was carried on, in his letter of transmittal to the Secretary of Agriculture, states that only two of the seventy-three species and races of rapacious birds found in the United States "need be taken into account as enemies to agriculture."

Before the investigations which resulted in this verdict were begun, it was the general belief, even among many observing and fair-minded people, that only two or three of the whole number were of any possible use to man. A study of the tabulated lists of stomach contents shows that this reversal of opinion rests solely on two factors. One of these is the relative amount of certain food-stuffs taken by the different species; the other is the character of the animal food preyed upon, whether formed of species noxious or beneficial to man from the agricultural standpoint.

Granting that the determinations of the first class were accurately made (and there is no reason whatever to doubt them), we may well inquire, By what standard do the zoölogists of the Department of Agriculture decide that certain species of mammals, birds, or insects, are considered to be noxious or otherwise? Nowhere in this work are the two classes defined, nor are any reasons given for the evident distinctions drawn between noxious and beneficial species enumerated in the food lists. The novice in such matters naturally seeks to know on what basis the doctors have decided for or against a hawk or an owl, but he is not informed, except as he can glean an item here and there among the biographies of the various species. This study reveals the following standards: (1) car-

nivorous mammals, mice, rats, gophers, and ground squirrels, as a class, are noxious; (2) birds, in their widest acceptation, which form the food of our hawks and owls are largely of species beneficial to agriculture; (3) reptiles and batrachians forming the prey of rapacious birds in the United States are, as a class, probably as noxious as otherwise; (4) insects preyed upon by these birds belong largely to noxious species; (5) of all the species of animals which are devoured by our rapacious birds in the eastern United States none is so largely and universally devoured or so harmful to agriculture as the common meadow mouse (*Microtus pennsylvanicus*).

I have striven to make these formulæ a conservative summary of the doctor's standards of good and bad as adopted in this valuable work. If it is a just summary, the author believes that the 1893 basis of judgment of our zoölogists in Washington is destined to undergo a radical change in some respects. It may already be doing so. Certain it is that the ideas conveyed in propositions *a*, *c*, and *e* are more or less erroneous, and in some features show a trace of the traditional prejudice which even scientific men often find it difficult to banish from their investigations.

To avoid misunderstanding, let us take the most flagrant case of a so-called noxious mammal, one which forms the bulk of the food of several of our hawks and owls which are nowadays rightly classed as the farmer's friends. The common vole, or meadow mouse (*Microtus pennsylvanicus*), belonging to the same subfamily of rodents as the northern lemming, is rated by nearly all who know him as the incarnation of agricultural pests. On this standard, and this alone, have Drs. Warren, Fisher, and Merriam based their verdict of the economic value of nearly two-thirds of the eastern species of hawks and owls which appear on their rolls of honor. The rough-leg hawk is accorded first place on this list because he eats almost nothing else but meadow mice of this species. But it is a stubborn fact that the case of the meadow mouse has never been proved against him. Not a tithe of the study devoted to his devourers has been given to him, and no scientific analysis of his stomach contents or food habits has yet been put on

record. His plea of not guilty stands good so far as the records of economic zoölogy are concerned. This may sound preposterous to every reader of the statement, but it is undeniable, and not more difficult to believe, after we have inquired into the facts of the case, than the conclusions of the modern zoölogist regarding some of our hawks and owls. "Of course, meadow mice live almost wholly on vegetable food, the grasses and grains of the farm, and that settles it." So retort the great majority, and until a very recent period the writer had thoughtlessly been one of that number. As a farmer, I have had ten years' acquaintance with the habits of the meadow mouse in Pennsylvania and New Jersey, and as a zoölogist, have made about six years' study of the same animal in ten eastern states. In that time about a thousand specimens have been secured and examined, and four hundred preserved for study. Without going into details, the following is a summary of my conclusions as to the economic status of this species, the common meadow mouse, *Microtus pennsylvanicus* of Ord :

1. From 90 to 100 per cent. of the food of this mouse throughout the year is vegetable, of which 60 to 80 per cent. consists of endogenous plants, chiefly grasses; 15 to 30 per cent. consists of exogenous plants, chiefly weeds; 5 to 10 per cent. consists of tubers and roots; and 1 to 5 per cent. consists of grain and seeds.

2. From 1 to 5 per cent. of its diet consists of animal matter such as other meadow mice, and the remains of dead animals.

3. Its vegetable food the year round is largely made up of "grasses," popularly so called, and during the summer season several species of native and introduced weeds form a considerable share of its diet.

4. Its destruction of grasses at all seasons is confined largely, and in the majority of cases almost exclusively, to the rushes (*Juncus*), sedges (*Carex*), salt grass (*Spartina*), Indian grass (*Andropogon*), and other coarse forms which have little or no agricultural value and are rejected by stock either as hay or pasturage.

5. 70 to 80 per cent. of the whole number of meadow mice in any given area restrict their habitat to low, moist soils,

bogs, and clearings, which are classed by the farmer as waste land or untillable meadow, and in these situations they consume almost nothing which would be utilized by the husbandman.

6. 20 to 30 per cent. are found on upland soils. Of these, nearly all confine their foraging to neglected fence rows, abandoned fields, weed patches, brush piles, rubbish, and litter, caused by that clog to American civilization, the shiftless farmer. In these situations the meadow mouse destroys nothing, but utilizes a great deal which otherwise would cumber the ground.

7. The arable land of every well-kept and cultivated farm or nursery, whether in pasture, grass, grain, orchard, truck, or young trees, is practically deserted by this mouse. In short, it can only exist where a food supply is found in conjunction with proper shelter, a shelter in almost every instance synonymous with neglect and waste on the part of the farmer and of utility on the part of the mouse.

8. The meadow mouse rarely eats grain except when the rigors of exceptional winters deprive it of green food. It then confines its appetite to what is found on or in the ground, and which has been exposed by the farmer's improvidence. It very rarely disturbs seeds, fruits, tubers, roots, or vegetables during the growing season and does little damage in winter to those buried in the ground, most of the ravages in these cases being the work of the short-tailed meadow mouse (*Microtus pinetorum*) and the white-footed mouse (*Peromyscus leucopus*).

9. On upland soils the meadow mouse is a surface feeder, forming its runways almost entirely above ground in the shelter of surrounding vegetation and débris. The burrowing of this species is confined chiefly to easily worked, moist lowlands, where it conduces largely to better drainage and an increase of vegetable growth.

To summarize the case briefly, it may be truly said that as a converter of waste vegetable matter into flesh-food for bird and beast the common meadow mouse has no rival in the regions it inhabits. Besides the numerous species of hawks and owls depending almost entirely on this mouse, other carnivorous birds, as the crow, jay, shrike, and heron, devour a

great many. It forms a large part of the menu of several of our mammals, as the wild cat, house cat, fox, marten, weasel, mink, raccoon, skunk, and opossum. The larger species of snakes, the bullfrog, and some of the turtles also devour them. Strike the meadow mouse from the food list of the tens of thousands of animals which devour him in the eastern United States, and the problems of the economic zoölogist would multiply an hundred fold.

The worst charges proved against him are: (*a*) the undermining and tunneling of artificial water barriers; (*b*) the destruction of a small amount of grain and vegetables not seasonably harvested or housed; (*c*) the consumption of a very small percentage of grasses which would have been utilized by the farmer; (*d*) the gnawing of the bark of fruit trees in severe winter weather.[1] The insignificance of these items compared with the value of the mouse as a tiller of the soil, a destroyer of weeds, utilizer of otherwise useless grasses, and a food supply for two-thirds of our carnivorous birds, mammals, and reptiles, is apparent. Exterminate the mouse, and the changed food relations resulting therefrom would cause the extermination of many most beneficial animals and the conversion of others into pests, to the greatest detriment of agriculture. Let us not forget, on the other hand, that any marked decrease of the animals which prey on the meadow mouse is equally to be deprecated, attended as it might be with similar consequences to the "vole plagues" of the old world. To maintain the balance of power between these neutralizing agencies, in the changed conditions imposed by advancing civilization, is the real province of economic natural science.

In 1894, the year following his publication of the volume on "Hawks and Owls," Dr. A. K. Fisher contributed an essay on "Hawks and Owls from the Standpoint of the Farmer," to the *Yearbook of the United States Department of Agriculture.*

[1] Dr. A. K. Fisher, in a recent answer to my inquiries regarding the possible economic value of the meadow mouse, denies that it is anything but a pest, and states that its destruction of trees in nurseries is alone sufficient to condemn it. I have since corresponded with two prominent Pennsylvania nurserymen, Mr. Thomas Meehan and the Wm. H. Moon Co., both of whom deny that they have suffered by this mouse to any extent.

On page 219 I find his first specific arraignment of the meadow mouse, a bit of information wholly lacking in the work of which the doctor's later article was a summary. After mentioning that America is free of the devastating hordes of lemmings which sometimes overrun northern Europe, Dr. Fisher says: "The vole or meadow mouse is common in many parts of this country, and is, east of the Mississippi River, without doubt the most destructive mammal to agriculture. It destroys meadows by tunneling under them, and eating the roots of grass. . . . This mouse also destroys grain and various kinds of vegetables, especially tubers, but probably does even more damage by girdling young fruit trees." There can be no doubt that Dr. Fisher refers primarily to the same species that I have been defending. The injustice of these accusations, as stated, is the more to be deplored, coming as they do from a scientist whose authority is taken as final by a large class of people. This fact, however, should never be construed as a point against the value of hawks and owls and other animals in preventing a vole plague in America. It only indicates that economic zoölogy is in its infancy, and shows the danger of allowing a greater truth to distort the lesser. Four years have elapsed since Dr. Fisher made his statement, — ample time for the officers of his bureau to have discovered that the greater part of the real damage done to vegetation by cutting of grass roots, eating of vegetables, seeds, and grain, and the girdling of young trees, is the work of another member of the vole family, the mole-like, short-tailed, rusty-backed pine mouse (*Microtus pinetorum*). The name mole mouse would better fit this energetic little burrower on whose shoulders rests the onus of most of the sins which we have unwittingly charged to the meadow mouse and the mole.

An hereditary prejudice may become an instinct stronger than our desire for scientific truth. One of the most popular and tenacious fallacies is the human hatred of reptiles and the desire for their wholesale extermination as noxious animals. The same remark will apply in large measure to skunks, minks, and weasels. Without being precise, it may be safely asserted that one-half of the food of our east American snakes consists of

mice (chiefly meadow mice) and insects. The remainder of their diet is made up largely of other snakes and reptiles, birds, batrachia, and fish. Undoubtedly Dr. Fisher recognizes the economic importance of the majority of our reptilia and batrachia, yet one cannot escape the suspicion that he has practically classed these as noxious because he has not taken the pains to declare them beneficial. He includes the swallow-tailed kite in the small list of those hawks "wholly beneficial" to the farmer. The tabulated lists and reports show that the food of this species is largely made up of insects, also of snakes, lizards, and other reptiles whose diet is quite as beneficial to agriculture, perhaps, as that of the kite. Nevertheless, the doctor says: "The snakes, lizards, and frogs it destroys, though by no means injurious to agriculture, probably will be regretted by few." We cannot but deprecate such a statement from such a source, for, though it does not condemn these animals, it implies that they are inferior or insignificant in the economic scale, — an imputation utterly without warrant, and serving to perpetuate the popular idea of their worthlessness.

The case of the swallowtail may serve as a striking illustration of nature's mysterious balance of good and evil:

> That not a worm is cloven in vain,
> That not a moth with vain desire
> Is shrivelled in a fruitless fire,
> Or but subserves another's gain.

On the basis of Dr. Fisher's statistics we will suppose a swallow-tailed kite to eat 100 insects, 2 chameleons (*Anolis*), 1 lizard (*Sceloporus*), and 3 grass snakes (*Cyclopis*) in one day. At first thought this should gladden our hearts. But an entomologist will say that 50 of those insects are tiger beetles, dragon flies, and wasps, the two former destroying hundreds of other insects, while the latter captures numerous flies and spiders daily. Avoiding the query as to what kind of insects the other insects eat, the herpetologist declares that the chameleons and the lizard and the green snakes daily devour among themselves about a thousand insects great and small. On the insect basis alone the problems of good and bad in this case are infinitely multiplied. From that point of view it looks, at best, like a

bad case for the kite. From another standpoint the evidence bears hard on the snake. As a variation to insect diet perhaps it has swallowed another snake. Is this an argument in its favor? Or it swallows a toad or frog, both of which live almost wholly on insect life. All this reminds us of Dean Swift's rhyme :

> So, naturalists observe, a flea
> Has smaller fleas that on him prey ;
> And these have smaller still to bite 'em ;
> And so proceed, *ad infinitum.*

So the plot thickens until we are tempted to despair of the utility of these investigations. A weed is a useful plant misplaced ; so also is the hawk, the mouse, the snake, or the insect a noxious animal when we unwisely alter the conditions of its struggle for existence. In nature's order all have their place in the economy of creation.

Two notable groups of injurious mammals in this country are the jack rabbits and the spermophiles, or ground squirrels, of the West. Their combined ravages amount to agricultural losses of tens of thousands of dollars annually and cover a vast extent of country. This condition of affairs has become a national question in the last decade, and was a state question long before that. The vast increase of these rodents is directly due to man's destruction of rapacious mammals, birds, and reptiles, especially of the coyote, or prairie wolf, in these regions ; also to the increased amount and improved quality of food supply attending the settlement of the country. This is a matter in which no restoration of primitive conditions is either feasible or desirable, except so far as rapacious animals, wrongly considered harmful, can be encouraged to increase. The effectual devices recommended in the Bulletins of the Department of Agriculture,[1] and adopted by our western brethren for the destruction of jack rabbits and spermophiles, as well as the noxious pocket rat, or gopher, are strong proof of the practical value of economic study along these lines.

[1] *Bulletin No. 4,* "The Prairie Ground Squirrels of the Mississippi Valley," 1893. *Bulletin No. 5,* "The Pocket Gophers of the United States," 1895. *Bulletin No. 8,* "The Jack Rabbits of the United States," 1896.

The following propositions may be considered as a synopsis of the conclusions arrived at in the preparation of this paper :

Firstly, the province of economic zoölogy should embrace (*a*) the study of the functions and habits of living creatures in their relations to nature and to each other, with special reference to the uses and welfare of mankind ; (*b*) the publication of the results of this study in a form most easily accessible to and understood by the public, with a view to correct popular errors and enlist the sympathy and coöperation of the people in the necessary reforms ; (*c*) the perfecting of legislation for the control of injurious, and the protection and encouragement of beneficial, species ; (*d*) the prevention of an unequal administration of economic laws, having in view the peculiar needs and industries of the region involved, and the varying circumstances of environment, the aim always being to secure the greatest good for the greatest number ; (*e*) giving the benefit of doubt as to the economic value of a species to the species in question ; (*f*) the recognition of the fact that true economy cannot ignore the æsthetic and the altruistic in its enforcement of utilitarian laws.

Secondly, concerning the subject of economic zoölogy as specially affecting the United States it may be said : (*a*) that, in general, experience has shown that the *extermination* of any native species on economic grounds is undesirable, but its *restriction*, temporary or continuous, may be a subject for wise legislation ; (*b*) that the damage done by many so-called noxious species is offset in a degree beyond calculation by the fact that they form a large share of the food of beneficial or harmless species, which, if deprived of this source of supply, would be exterminated or become harmful by recourse to an unnatural diet ; (*c*) that in the United States we have large areas so nearly in their virgin state that the balance of nature there existing may be taken as a criterion by which to restore the most natural order compatible with the changed conditions of populated districts ; (*d*) that the unwise destruction of so-called noxious species in this country has not gone so far toward extermination that present-day reforms will fail to be a remedy, as is the case in Europe ; (*e*) that the unity of our

country in the direction of interstate and national legislation has developed early enough for us to conserve the natural productions of the United States in a manner now impossible among older nations; (*f*) that the unparalleled deforestation and agricultural settlement of the lands of the United States and the importation of foreign species of animals and plants to her shores has so suddenly and materially affected our climatic and zoölogical conditions that nowhere else in the world has there been presented such a variety of important economic problems; (*g*) that owing to our exceptional facilities for the study of these problems by a corps of trained students and scientists so competent to solve them, and a people so alive to the necessity of education and reform, the civilized world is looking to us for results in economic research commensurate with the money, time, and brains invested, and the demands of a progressive century.

A POCKET MOUSE IN CONFINEMENT.

J. A. ALLEN.

THE arid plains and deserts of the West are inhabited by many kinds of small rodents, some of which, like the pocket mice, the kangaroo rats, and most of the pocket gophers and prairie dogs, are peculiar to these arid areas, and constitute their most characteristic forms of mammalian life. They range in greater or less abundance and diversity of forms from near the northern boundary of the United States to southern Mexico. Their habits of life are such that they must pass much of each year without access to water, and the question has often been raised as to whether they are able to exist without water, deriving sufficient moisture from the seeds and fresh vegetation that form their food, or whether they sink burrows or "wells" to a sufficient depth to obtain it from subterranean sources. In the case of prairie dogs this latter theory has received wide acceptance, but, of course, has never been demonstrated.

The few observations that have been made on captive animals belonging to these several groups have sufficed to show that access to water is not essential to their welfare in captivity; but perhaps no instance affording quite such satisfactory evidence has been given as the case here related. In the summer of 1895 a valued correspondent and well-known naturalist, Mr. H. P. Attwater, of San Antonio, Texas, captured near San Antonio a number of living examples of two species of pocket mice (*Perognathus mearnsi* Allen and *Perognathus paradoxus spilotus* Merriam), which he kept alive during the following winter and kindly sent, still alive, by express to the American Museum of Natural History, New York City, in June, 1896. There were four individuals, two of each of the species named above. One of the larger (*Perognathus paradoxus spilotus*) died on reaching New York, from the effects of the journey; the other lived contentedly for several weeks in an open box

covered with wire netting, but finally escaped and was lost. Of the two smaller (*Perognathus mearnsi*), one soon died, and the other is still living, in apparently good health, after confinement for nearly four years. Mr. Attwater stated that during the time he had them they "fed readily on cane seed, oats, and corn, but had received no water." Also that these little creatures "when kept in confinement become very tame, and seem to like to be handled."

On arriving in New York, water was supplied them regularly for several weeks, but as they appeared to make no use of it, it was soon omitted from the bill of fare, which consisted exclusively of mixed bird seed. Our present captive has had no water offered him for nearly three years. His domicile is a tin box, about 14 inches by 20, and 10 inches deep, open at the top, but with a thick layer of earth at the bottom, which it forms his chief occupation to tunnel and transform, by heaping it up first in one corner and then in another. As he is strictly nocturnal in habits, little is seen of him, unless he is forced to come out by being disturbed in the daytime. He is readily susceptible to the influence of low temperature, and in winter, when the temperature falls to 60° F. or a little below, will remain for days in apparently a state of temporary hibernation.

When an ounce or two of mixed seed is supplied him at one time, he either works industriously till all is hidden away in his underground galleries, or he diverts himself by sorting out the different kinds of seed and making separate deposits of each kind in different corners of the box, above ground.

As no water and no fresh vegetation have been given him for nearly three years, it is evident that the only moisture required for his sustenance is derived wholly from dry bird seed. This seems to demonstrate that these little desert animals, often found living far from any sure source of water supply, are fitted by their organization to exist entirely without access to that element which to ordinary animals is so indispensable, and generally thought to be essential to at least all mammalian life.

AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK CITY.

EDITORIAL.

The Need of an American "Leuniss." — Of making books, we are told, there is no end; but there is one kind of book which we Americans need which has yet to be made. The greatest desideratum is a work after the pattern of the German "Leuniss," which is in constant use in every laboratory and museum abroad, but which is unrepresented by any corresponding work in the English language. It is now many years since Leuniss issued the first edition of a synopsis of the three kingdoms of nature, and the work now consists of seven large volumes, two treating of zoölogy, three of botany, and two of mineralogy and geology. These give general accounts of the various groups and follow by giving analytical keys to the principal families, genera, and species, the typical forms being illustrated by thoroughly characteristic engravings. As we have said, there is nothing to correspond in the English language, and for American students a translation would be of little value, as our flora, fauna, and geology are so different from those of central Europe. What we must have is a similar work in which American forms are made prominent. It is true that we have several manuals which include parts of our forms: Jordan has treated of our vertebrates, Gray some of our flowering plants; there is a considerable literature upon insects, ferns, mosses, etc., but the general work has yet to be written. No one man can do the work; it must be by the coöperation of several or even many specialists, and we have in our country the necessary specialists to produce a work which will be far ahead of its German prototype. In the hands of our publishers, our magazines, and of the United States government, are numbers of cuts which could be available for illustration. We wish that we were able to announce that such a work was in preparation, but unfortunately no intimations of the prospects of such a work have reached us. The *American Naturalist* will do all in its power to further such a work, should it be undertaken.

REVIEWS OF RECENT LITERATURE.

ANTHROPOLOGY.

Fouilles a Brassempouy, en 1896.[1] — Several notices have appeared during the last three or four years of the discovery of statuettes and other paleolithic remains at Brassempouy in southwestern France. In a recent number of *L'Anthropologie* MM. Piette and Porterie have given a brief description of their explorations in 1896. In the caves were found large quantities of horse, hyena, and other animal bones, etchings of animals, paleolithic implements, and a small but well-executed carving representing the figure of the human female. The statuette is broken and incomplete, and is not quite symmetrical, yet it is a "remarkable object of art," considering the tools with which the ivory was worked. The stone implements and weapons are similar to those of Cro-Magnon and Gorge-d'Enfer, and those who made them probably belonged to the "Dordogne School of Art" of glacial times.

FRANK RUSSELL.

The Ethnology of Funafutti.[2] — During the summer of 1896 Mr. Charles Hedley, of the "Funafutti Coral Reef Boring Expedition," collected a number of ethnological specimens from the Atoll of Funafutti. Brief descriptions of these with accompanying figures are given, together with numerous references to the literature relating to Polynesia. The author says in his introduction: "On glancing over the ground covered by the following paper my predominant impressions are: firstly, the poverty of our knowledge of Polynesian Ethnology, and the superficial way in which it has been studied; and, secondly, the rapidity with which the knowledge of it that might yet be gathered is vanishing." This warning has been given by many writers and in relation to many other lands as well. We believe that for some time to come those who have an opportunity to study these peoples

[1] Études d'Ethnographie prèhistorique; Fouilles à Brassempouy, en 1896. Ed. Piette and J. de la Porterie. *L'Anthropologie*, T. viii, pp. 165–173.

[2] The Atoll of Funafutti, Ellice Group. Charles Hedley, Australian Museum, Sidney, *Memoir III*, Pt. iv, pp. 229–304.

can occupy themselves much more profitably with the examination of physical characters than in the elaboration of theories of origin and of migrations. The scanty somatological data furnished in this paper show that the Funáfutti natives are a brachycephalic (index 82.5) race of medium stature (M 1.67). Mr. Hedley's descriptions of their technic arts are clearly and concisely written, and form a valuable contribution to our knowledge of the culture of Oceania.

FRANK RUSSELL.

The Mounds of Louisiana.[1] — In a paper of twenty pages Professor Beyer has described his explorations among the mounds of north-eastern Louisiana. Several skeletons were found, but in such a fragile condition that they could not be preserved. An attempt is made to establish the cranial type from four measurements taken upon five more or less fragmentary skulls, and to prove its southern affinities by comparison with a single Carib skull! With equal success we have recently compared the three principal diameters of the brain case of a series of thirty-three Eskimos with the fifty blacks from Torres Straits, described by Flower! The pre-Columbian type is presumably depicted in the two unnumbered plates entitled "Larto skull" and "Larto skull restored." If this skull were properly oriented, say, about forty-five degrees forward, the "type" would be transformed into an ordinary Indian cranium.

A few specimens of pottery were found, one of which is ornamented with an artistic design containing the Maltese cross and the swastika; that it is "entirely too fine in execution to be ascribed to our North American Indians" is an error manifest to any one at all familiar with American ceramics.

FRANK RUSSELL.

ZOÖLOGY.

The Segmentation of the Head. — This perennial problem has been attacked again by Dr. H. V. Neal,[2] who has based his work upon the early stages of the common dogfish of the New England

[1] Beyer, Prof. George E. *Publications of the Louisiana Historical Society.* New Orleans, La., 1898.

[2] The Segmentation of the Nervous System in Squalus Acanthias. *Bulletin Mus. Comp. Zoöl.*, vol. xxxi, No. 7, 1898.

coast. Only a few categorical statements can be made here concerning his conclusions. The work was begun to ascertain in how far the neuromeres of Locy could be used in solving the problem of the number of segments in the vertebrate head. His conclusions on this point are that these structures are not of segmental value ; that in no case are they symmetrical on the two sides of the embryo, and no definite relations to the somites could be ascertained. Again, he has been unable to trace these dorsal structures into the hind-brain neuromeres. Neal regards them, and this opinion seems plausible to the reviewer, as results of unequal growth along the margin of the ventral plate. He differs, too, from Locy in his determination of the posterior limits of the expanded cephalic plate, the posterior boundary of which corresponds to the hinder margin of the later auditory invagination.

Next Dr. Neal considers the neuromeres of Orr. In the hind-brain region he accepts these structures as metameric in character, but points out that Orr's criteria apply only to the later stages ; in earlier embryos the constrictions separating the neuromeres are not only lateral, but dorsal and ventral as well. These neuromeres are entirely independent of influence from the mesoderm, and as paired ganglionic enlargements of the central nervous system at once suggest comparisons with the ventral cord of annelids. In the region of the spinal cord, on the other hand, the neuromeres differ somewhat in structure and development from those of the hind-brain, and their existence, at least in part, seems to depend upon the adjacent segments of the epimere.

The so-called neuromeres of the fore- and mid-brain regions are not equal to those of the other part of the brain, as they are later in appearance and are cœnogenetic in character. The two primary vesicles, fore-brain and mid-brain, are each of neuromeric value. So, counting all these, Neal recognizes one each for the fore- and mid-brains, and five in the hind-brain back to the "Urvagus," a total of seven in the primitive head. He fails to see marked differences between the pre- and post-auditory regions of the head, and regards the somites as serially homologous.

The relations of the neuromeres to other apparently segmental structures is then taken up with the following results, the table being slightly altered in its arrangement from that of Neal :

Neuromeres.	Somites.	Nerves (dorsal).	Nerves (ventral).	Visceral Clefts.	Visceral Arches.
I	"a"	I (olf.)	lost		1
II	1	oph. pr. V.	III	lost	1
III	2	V	IV	mouth	1
IV	3	(V)[2]	(VI)[2]	lost	(1)[2]
V	4	VII	(VI)[2]	1	2
VI	5	IX	(VI)[2]	2	3
VII	6	X	VI	3	4
VIII	7	X	1 spinal[3]	4	5
IX	8	1 spinal[4]	1 spinal[3]	5	6
X	9	2 spinal[5]	1 spinal[3]	6	lost[6]
XI		3 spinal[5]		lost[6]	lost[6]

Neal further concludes that there was originally a correspondence between neuromerism, mesomerism, and branchiomerism, and that a visceral arch has been lost in the region of the fourth neuromere. The segments VIII to XI have been added from the trunk region to the occipital region, the number varying in different vertebrates.

Many details are given of the development of the neural anlagen nerves, somites, etc., and comparisons are made with Amphioxus, the results of which are summarized as follows:

"In agreement with van Wijhe, I homologize the mouth of Amphioxus with the left half of the mouth of Craniota. The first pair of permanent visceral clefts in Amphioxus are exactly homologous with the hyomandibular clefts of higher vertebrates. The eight visceral clefts possessed by Amphioxus at its 'critical stage' (Willey) are exactly homologous with the eight morphological clefts found in some Selachii and Cyclostomes."

Closely connected with the subject of this paper by Dr. Neal is a shorter but suggestive article[7] by Mr. Cole, which, however, is based upon the anatomical rather than the embryological side of the problem. The matter is so condensed as to admit of no satisfactory abstract, since it deals not with new investigations, but is rather a summary of conclusions drawn from existing knowledge.

[1] Possibly represented by labial cartilages.

[2] Theoretical relationships.

[3] From the first three roots of the embryonic hypoglossal.

[4] Fuses with dorsal ganglion of X.

[5] Ganglia disappear in development.

[6] Found in Diplospondyli.

[7] Reflections on the Cranial Nerves and Sense Organs of Fishes, by F. J. Cole. *Trans. Liverpool Biol. Soc.*, vol. xii, 1898.

The Stomach of Migrating Salmon. — An interesting study of the histological changes which the digestive tracts of salmon undergo during the migrations of these fishes from salt to fresh water, and the reverse, has been made by G. L. Gullard.[1] At about the time the salmon begin to ascend the rivers, or even before, their digestive tracts are affected by a desquamative catarrh by which most of the digestive epithelium is shed. After the fish have reached the high waters and laid their eggs, the stomach reassumes its normal epithelium, and on their return to the sea the epithelium of the intestine is regenerated. The desquamation is evidently not directly or indirectly dependent on the action of fresh water, for it may occur in fish that are still in salt water. It is more probably associated with changes in the feeding habits of the fish correlated with the breeding season.

G. H. P.

Terminology of the Central Nervous System. — The Association of American Anatomists has issued in the form of a pamphlet the majority and minority reports of its committee on anatomical nomenclature. The reports deal with the terminology of the central nervous system. The majority report, after a historical summary, discusses briefly four categories of terms: first, twenty-three terms common to the list of the committee's secretary and that of the Anatomische Gesellschaft; secondly, seventy-eight terms common to both lists, but with slightly different usages; thirdly, fifteen terms largely different in the two lists, but receiving considerable American support; and, finally, two hundred and fifty-nine terms differing more or less from those adopted by any other organization. The majority report is obviously a radical measure, and it is against this side of it that the minority report is directed. While the reports contain some happy suggestions as to changes in particular terms, and much that is valuable on the principles of a logical and convenient nomenclature, they differ from each other so radically that anything approaching the adoption of a uniform system on the part of the committee would seem well-nigh impossible.

G. H. P.

Processus Odontoideus Atlantis Hominis. — In 126 atlas vertebræ examined by Dr. E. Funke,[2] two were found to have what may be

[1] Gullard, G. L. The Minute Structure of the Digestive Tract of the Salmon, and the Changes which Occur in it in Fresh Water. *Anatomischer Anzeiger*, Bd. xiv, pp. 441–455.

[2] Funke, E. Ueber einen Processus Odontoideus Atlantis Hominis. *Anatomischer Anzeiger*, Bd. xiv, pp. 385–390.

called odontoid processes. These processes have been interpreted in the following way: the bodies of the atlas and axis, like those of most other vertebræ, have each two centers of ossification, a cranial and a caudal one. Ordinarily all these four unite in the adult to form the body and odontoid process of the axis, the atlas having no true body. In the exceptional cases above noted, it is supposed that only the caudal ossification of the atlas united with the body of the axis to form the odontoid process, and that the cranial ossification remained in place, thus producing an odontoid process on the atlas. G. H. P.

Comparative Anatomy for Medical Students. — In the June number of the *Columbia University Bulletin*, Prof. G. S. Huntington has an able article on the importance of vertebrate comparative anatomy for medical students. The article outlines the policy which is shaping the teaching of anatomy in the medical department of Columbia, and will be encouraging to those teachers who, in preparing students for medical studies, have insisted upon the importance of vertebrate comparative anatomy as a key to the interpretation of human structure. G. H. P.

The "claspers" or modified posterior edges of the pelvic fins of Elasmobranchs have been made the subjects of study by H. F. E. Jungersen.[1] The skeleton, muscles, glands, and integumentary investments of these organs are described first in Chimæra and then in the sharks and rays. The probable function of these parts is alluded to, and while no new observations are recorded on this little-known subject, the inference is drawn from the structure of the parts that they cannot be used as "claspers" or external "holders," but they can be effective as hold-fasts only after they have been inserted in some opening such as the female cloaca. G. H. P.

Cope's Lectures on Vertebrates.[2] — For the past half dozen years students of the vertebrates have found the first edition of the present work indispensable, as it brought into a small compass a clear and concise summary of all the labors of Professor Cope upon the classification of the vertebrates, living and extinct. As the previous edition

[1] Jungersen, H. F. E. Ueber die Bauchflossenanhänge (Copulationsorgane) der Selachiermännchen. *Anatomischer Anzeiger*, Bd. xiv, pp. 498–513.

[2] *Syllabus of Lectures on the Vertebrata.* By Edward D. Cope. With an introduction by Henry Fairfield Osborn. University of Pennsylvania, 1898. $1.25 (paper covers $1.00).

was prepared primarily for the use of the students of the University of Pennsylvania, and was not placed on general sale, its use was greatly restricted. The present edition has been brought up to date, and its preparation was one of the last works of the author, the preface bearing the date 1897. Among the changes of interest, we note the inclusion of not only Balanoglossus but Cephalodiscus and Rhabdopleura in the chordates; the recognition of Paleospondylus and the Astracopphri as cyclostomes and the rehabilitation of the Stegocephali. The work will long remain a necessary assistant to every student who wishes to really study vertebrates. One may differ with the author upon minor points of his system, such as the retention of his groups Rhachitomi and Embolomeri; with the exclusively osteological basis of his classification, which, however, was a necessity in dealing with fossil forms, or with the outrageous forms, — carbonic, cumbric, etc., — adopted for the geological periods; but when all this fault is found there remains behind a work of which any one might be proud.

The introduction to the volume consists of a short sketch by Professor Osborn of the life and the works of Professor Cope, presenting in clear form the many advances both in knowledge of fact and in generalization which we owe to America's greatest comparative anatomist.

Packard's Text-book of Entomology.[1] — Professor Packard's new text-book of entomology appears at a most opportune time. The influence of the book because of the kind of entomology it illustrates and illumines will be very great and very valuable. As a reference and text-book of the morphology, physiology, and development of insects, it takes for these lines of study that position of authoritative and indispensable guide which *Comstock's Manual* takes for the study of the taxonomy and "life-history" of insects. With these two manuals of insect study, the English-speaking students of entomology are better provided with book guides than are the students of any other country.

Because there are hundreds of thousands of insect species, and because the finding and setting in order of species was the first business of naturalists, most entomologists have given most of their time to helping in this business of species finding and distributing.

[1] *A Text-book of Entomology, including the Anatomy, Physiology, Embryology, and Metamorphoses of Insects.* By A. S. Packard, M.D., Ph.D. The Macmillan Co., New York, 1898. 8°, pp. xvii, 729, with 654 figs. $4.50.

The work is necessary and will never be abandoned. But while some of us have kept exclusively at this sort of work, others have begun to study insects from other points of view. What these others have done is pretty fairly set out in Dr. Packard's new book. From a knowledge of what has been done come the knowledge of what there is to do and the inspiration to do it. If this work done and to be done is an especially interesting and especially important kind of work, the pioneer text-book of such work is especially valuable and helpful. That the kind of entomology treated of in Dr. Packard's text-book is especially important and interesting will not be questioned in 1898 nor thereafter.

The author of such a text-book has a large undertaking on his hands, and one to which a great deal of time may be given. To decide on the quantity of matter to be included and the character of its treatment is a nice question, and opinions regarding it will most certainly vary. Dr. Packard is an entomologist widely acquainted with the work done by other entomologists and zoölogists, and especially capable, from his own wide range of study, to judge of the value of this work. He is in a position to write as an authoritative critic. We (if there are others of my way of thinking) should wish, then, to have him present in a text-book of entomology what seem to him, from his own investigations and from his knowledge of the observations and theories of others, the facts and theories accepted by the consensus of authority. We want a well-digested, clearly presented, authoritative statement of the present knowledge of insect morphology, physiology, and development. This, it seems to me, Dr. Packard has not wholly done. The author has wished to be very fair. He presents to us the original sources of his knowledge. He displays the contradicting observations and speculations of investigators; he quotes German and French writers in their own words and sometimes in their own language; he is strenuous to give credit to whom credit is due. This is delusive fairness. It is too much to expect, it is confusing, it is impossible for a text-book to give credit for all facts. It is impossible for Dr. Packard to give all the observations and theories pertinent to the structure and physiology of the Malpighian tubules or to the origin and development of the imaginal discs. But it is wholly possible for him to give us, regarding the Malpighian tubules and the imaginal discs, a statement of the present knowledge of these organs made by the man best fitted, probably, of all men in America to make an authoritative statement of such knowledge. This is one conception of what such a text-book from Dr. Packard should

be; and it probably is not Dr. Packard's; or if it is, he has not had the time to attempt such a complete digestion of the mass of observations and theories which he has had before him; and the matter of time is an influencing one in almost all work.

Dr. Packard's text-book need not be compared with similar ones in other languages, because there is no other one which at all approaches it in comprehensiveness or construction. Kolbe's *Einführung in der Kenntniss der Insekten* does not touch embryology nor post-embryonal development, nor hardly physiology; Camerano's *Anatomia degli Insetti* is insignificant; Lowne's *Blowfly* and Miall and Denny's *Cockroach* are of a different type, and one lacks authority while the other is old. Dr. Packard's is the one book covering the field of its subject, and it becomes at once the authoritative text.

It will be unnecessary to call attention to details of the book's construction. The logical arrangement and sequence of subjects, the wealth of illustration, the full lists of well-selected references, and the complete index are noticeably good features. The author is a veteran bookmaker and understands the importance of caring for the convenience of the book-user. The publishers have admirably aided the author in making the book usable, and have put it into substantial and pleasing form. The type-face is large and clean, and the "style" characteristically good.

The book is indispensable to teachers of entomology and zoölogy and to students of insect morphology and development. Whether it will be extensively used in "agricultural and technical schools and colleges," is a matter to be determined by time. There is no doubt that it ought to be so used, and cannot fail, in any case, to help better the opinion entertained by foreign scholars of American biology. Zoölogists and entomologists are under real obligations to Professor Packard for the material aid he has given them in writing the book.

STANFORD UNIVERSITY, CALIFORNIA. VERNON L. KELLOGG.

Faune de France.[1] — This is a convenient handbook for the purpose of the determination of the insects of France. It treats of all of the orders of this class except the Coleoptera, which form the subject of an earlier volume. It consists entirely of analytical tables. These include all of the genera represented in France; and, except in the case of a few families, tables of species are also given. The

[1] Aclogue, A. *Faune de France.* Paris, J. B. Bailliere et Fils, 1897. 12mo, 516 pp., with 1235 figs. $2.00.

work has the appearance of being well done; but its aim is purely systematic, and the point of view is that of a generation ago, when, much more generally than now, the object of the student was to label the specimens in his collection and to arrange them in an orderly manner. C.

Revision of the Melanopli.[1] — This is a monograph of that division of the Acridiidæ or short-horned grasshoppers which includes our common red-legged locust, the Rocky Mountain locust, and other well-known forms. The group includes thirty genera (eighteen new) and 207 species, of which 115 are here described for the first time. As the work is done in that thorough manner which is characteristic of Mr. Scudder's monographic work, it is obvious that this is an exceedingly important contribution to our knowledge of the orthopteran fauna of North America. One cannot go over the pages of the book before us without being impressed with the devotion of the worker, as shown by the infinite care and patience with which the descriptions have been made. C.

Handlirsch's Monograph of the Phymatidæ; Fernald's Pteŕophoridæ of North America. — Handlirsch's "Monographie der Phymatiden" (*Ann. k. k. nat. Hofmuseums*, 1897, Bd. xii, No. 2, pp. 127–230, taf. 4–9) is a well-planned and well-executed systematic study. The work of previous investigators is stated in sufficient detail, and there are brief notes relating to the morphology, anatomy, development, life-habits, geographic distribution, systematic position, and relationships of the family. The tabular separations of the subfamilies, genera, and species, and the descriptions of the genera and species are clear and concise; three new genera and twenty-eight new species are described. Handlirsch recognizes three subfamilies, the Phymatinæ, Macrocephalinæ, and Carcinocorinæ; of Phymata, the only genus of the Phymatinæ, there are twenty-five species, two from Europe and the others from North and South America and the West Indies. Four species are noted from America, north of Mexico, and of *Phymata erosa*, the well-known ambush-bug, many subspecies, ranging from Canada to Chili, are described. Scott's two species from New Zealand are doubtfully placed here. There are six genera and forty-three species of Macrocephalinæ; thirty of the latter are

[1] Scudder, S. H. Revision of the Orthopteran group Melanopli (Acridiidæ) with special reference to North American forms. *Proc. U. S. Nat. Museum*, vol. xx, pp. 1–421, with Pls. I–XXVI.

placed in Macrocephalus. The species of Macrocephalus have the same distribution as those of Phymata, and, as with Phymata, but four species are found in America, north of Mexico. The habitat of the single species of Oxythyreus is not known; Amblythyreus, six species, Cnizocoris, two species, and Glossopelta, three species, are all from the Indo-Asiatic region; Agrenocoris, with a single new species, is, with doubt, credited to Mexico. The subfamily Carcinocorinæ consists of two genera, Carcinocoris, two species from Indo-Asia, and a single species of Carcinochelis, described as new, from an unknown habitat. The plates and cuts adequately illustrate the text.

A striking contrast to this careful, original monograph of Handlirsch may be found in "The Pterophoridæ of North America," by C. H. Fernald (*35th Ann. Rept. Mass. Agric. College*, January, 1898, pp. 83–163, 9 pls. Separate: January, 1898, 80 pp., 9 pls.).

Professor Fernald devotes less than a page to geographical and geological distribution, economic importance, and natural enemies; the history and structure of the family are stated in less than eight pages, and there are very brief notes on the habits and early stages. The greater part of the work is given over to an account from a systematic standpoint of the six genera and fifty-eight species found in America, north of Mexico; a notice of *Orneodes hexadactyla* is added.

The whole work is essentially compiled; it contains hardly an original line from a biologic point of view; of early stages the descriptions and accounts are, almost without exception, surrounded by quotation marks, and though the author is stated, the reference to the place of publication is frequently omitted. While this paper by Professor Fernald may serve the purpose of calling attention to our plume-moths or feather-wings, it will hardly enhance the reputation of its author. It shows everywhere carelessness in preparation and haste in publication. Important references to descriptive matter, previous notices of food-habits, of early stages, and records of habitats are omitted; species treated in the text are left out of the tables; a species appears in the text under one name and in the table under a different name; the bibliographic references are not uniform; Zeller's paper (1873) is cited, on the first pages, "Beit." and later on as "Verh. z.-b. Ges. Wiens."; the number of specimens studied is given in some cases; in others it is not given; direct detailed references from text to plates are not given.

Plate I shows the external morphology of *Pterophorus monodactylus;* of the other plates two are given over to venation, the others to geni-

talia. The genitalia, though thus elaborately illustrated, are hardly referred to in the descriptions. On page 135 *Pterophorus ambrosiæ* is put down as a synonym of *P. inquinatus*, a conclusion that seems more than doubtful when Pl. IV, Figs. 3, 4, and Pl. VI, Figs. 14, 15, are compared.

The index of genera and of species issued with the separately paged reprints might have been omitted, as the references are to the original pagination, not to the pagination of the reprint. January, 1898, on both the report and reprint, should not be considered as the date of publication, as the first advance copies were not sent out from the state printers until March 31, 1898.

Finally the publication in an agricultural report of a systematic account of a family of so slight economic interest as the Pterophoridæ may well be criticised, especially when so many species of prime importance to agriculturists await adequate treatment.

S. H.

BOTANY.

The Morphology of Spore-producing Members. — With the improvements in microscopical technique and the increasing availability of tropical types there have been during the last decade great additions to our knowledge of the structure of all groups of plants, and the pteridophytes have not been neglected. As might be expected, these investigations have not always confirmed the older views, and perhaps nowhere is this more marked than among the ferns. Until quite recently it has been generally accepted that the Leptosporangiatæ, especially the Hymenophyllaceæ, were the more primitive ferns from which the Eusporangiates, the Ophioglossaceæ, and Marattiaceæ, have sprung. The result of these recent studies has been to throw much doubt upon this view, and to make it reasonably certain that the latter groups are really the older ones, while the leptosporangiate ferns represent comparatively recent specialized types, which have arisen from eusporangiate ancestors.

No more important contributions to this very interesting subject have been made than the series of studies upon spore-producing members, of which the present paper[1] is the third. Professor Bower

[1] Bower, F. O., Sc.D., F.R.S. Studies in the Morphology of Spore-producing Members, Marattiaceæ. *Phil. Trans. Roy. Soc.*, Ser. B, vol. 189, 1897, pp. 35–81, Pls. 7–11.

has already given us a very accurate account of the development of the sporangia in the lycopods, Equisetineæ, and Ophioglossaceæ, together with most important conclusions as to the origin of the different sporangial types and the relations of these to one another. In the present paper he has taken up the second order of the Eusporangiatæ, the Marattiaceæ, and has given us by far the most complete account of the sporangia of these interesting ferns that has ever been published. All of the existing genera are treated at length, and in addition there is a most valuable discussion of the relation of these to the different fossil types.

The Marattiaceæ comprise at present four genera, two of them monotypic, of tropical ferns of very characteristic structure. Of these, Marattia is represented in both the Old and New World, but the others are more restricted in range. Danæa is peculiarly American; Angiopteris and Kaulfussia, each with but a single species, belong to the Old World.

The Marattiaceæ show many primitive structural characters, and it is now known that most of the palæozoic ferns were closely related to existing marattiaceous types. Owing to the difficulties in procuring suitable material for studying the development of the sporangia, the earlier studies on these were mostly fragmentary, and entirely confined to the two genera Marattia and Angiopteris. This makes the careful study here given of the sporangia of Danæa and Kaulfussia of more than common interest.

In all the Marattiaceæ except Angiopteris the individual sporangia are imperfectly delimited, and the sorus is often spoken of as a "synangium," although it is much more probable that this is the primitive condition than a case of cohesion of originally free sporangia. Bower very properly considers each group of sporogenous cells as a single sporangium, and speaks of it as a sporangium.

The development of the sporangium is much alike in all of the genera. The sporogenous cells arise, as a rule, from a single hypodermal cell, whose sister-cell forms part of the wall of the ripe sporangium. Exceptions occur and it is not always possible to refer the sporogenous complex to the division of a single mother-cell.

In Danæa the sori are much elongated, and almost completely cover the lower surface of the sporophyll, extending from the midrib to the margin, and almost or quite touching each other laterally. In this genus the sporophylls have the segments decidedly smaller than the sterile leaves, and in this respect Danæa recalls many leptosporangiate ferns, or the Ophioglossaceæ. The occasional presence of

imperfect septa in the loculi and a partial overarching of the sorus by the leaf tissue recall the structure of the sporangium in Isœtes, which it has been suggested more than once may possibly be remotely related to the Marattiaceæ.

Kaulfussia differs from Danæa principally in the much wider expanse of the leaf surface and a consequent separation of the small, nearly circular sori; but in essential structure the sporangia of the two are much alike, and Bower considers that the two are nearly related.

Marattia and Angiopteris have been studied more or less completely by other investigators, but they were also examined carefully by Professor Bower, and some additional information in regard to the development of both of them was obtained. In Marattia the presence of a mechanical tissue, having to do with the dehiscence of the sporangium, and an occasional partial septation of the loculus, as in Danæa, are the most noteworthy of these new facts. In Angiopteris abnormalities were sometimes noted, the most striking being sporangia of unusual size, suggesting a condition intermediate between the normal sporangia and the synangia of the other genera. Angiopteris alone is provided with a genuine, though rudimentary, annulus, and there are special thin-walled cells upon the ventral surface of the sporangium where it opens.

A comparison of the number of spores produced is made, from which it appears that Angiopteris and Kaulfussia mark the extremes. The former produces approximately 1450, the latter 7850 spores in each sporangium, numbers far in excess of those in any leptosporangiate ferns.

An interesting comparison is made with the lower members of the leptosporangiate series of ferns, and it is pointed out that the type of sporangium found in the Marattiaceæ has certain resemblances to that of the Osmundaceæ, Gleicheniaceæ, and Schizæaceæ, a point which may well be borne in mind in future studies as to the affinities of the lower Filicineæ.

A most valuable summary of the more important facts connected with the fossil Marattiaceæ is given, from which it appears that while certain of the fossil genera, *e.g.*, Danæites, conform closely in structure to existing types, others are to some extent synthetic in character. Thus Scolecopteris combines characters belonging to Marattia, Kaulfussia, and Angiopteris, while others show characters which would seem to indicate that they are forms connecting the Marattiaceæ with the lower leptosporangiates.

In summing up the evidence obtained from a comparative study of the living and fossil Marattiaceæ, Professor Bower recognizes the difficulties in reaching positive conclusions. However, while admitting that any conclusions reached must be subject to modification, his own view (p. 69) is that the circular sorus, like that found in the fossil Asterotheca, probably is the primitive type from which the others have been derived. The difference in form of the sorus, especially the extreme elongation in Danæa, is correlated with extension of the leaf surface. In another direction, by repeated constriction of the elongated sorus, the numerous scattered sori of Kaulfussia may have arisen.

It is to be regretted that our author did not make a fuller comparison of the Marattiaceæ and Ophioglossaceæ. He expresses no opinion as to the affinities of the two, beyond calling attention to the resemblances between the sporangial spike of Ophioglossum and the elongated sorus of Danæa, which resemblance he does not regard in the light of a true homology.

We are promised a study of the Leptosporangiatæ which will be awaited with keen interest by all students interested in these most important problems, which bear directly upon the question of the origin of the flowering plants as well as the ferns.

STANFORD UNIVERSITY,
May, 1898.

DOUGLAS HOUGHTON CAMPBELL.

Recent Inexpensive Popular Literature on Mushrooms. — The following papers more or less useful to collectors and eaters of fleshy fungi have come to our table within the year:

"Suggestions to Collectors of Fleshy Fungi," by Prof. L. M. Underwood. Reprinted from *Bull. 80 Alabama Agri. Exp. Station.* Cambridge Bot. Supply Co., Cambridge, Mass., July, 1897. 14 pp. Price, 25 cents.

"Mushrooms and Their Use," by Charles H. Peck, State Botanist of New York. 8vo, 80 pp., 32 cuts. Reprinted from *Cultivator and Country Gentleman*, Albany, N. Y., 1894. Cambridge Bot. Supply Co., May, 1897. Price, 50 cents.

"How to Grow Mushrooms," by William Falconer. *Farmers' Bulletin No. 53*, Division of Vegetable Physiology and Pathology. U. S. Dept. of Agriculture, Washington, D. C., March, 1897. 8vo, 19 pp., 14 figs. Free on application.

"Observations on Recent Cases of Mushroom Poisoning in the District of Columbia," by F. V. Coville. *Circular No. 13.* U. S.

Dept. of Agriculture, Division of Botany, Dec. 1, 1897. 21 pp., 21 figs. Free on application.

"Collecting and Preparing Fleshy Fungi for the Herbarium," by Prof. Edward A. Burt, *Botanical Gazette*, March, 1898. 8vo, 14 pp., 1 pl. Reprints of this may be had from Cambridge Bot. Supply Co., Cambridge, Mass.

"Some Edible and Poisonous Fungi," by Dr. W. G. Farlow, Professor of Cryptogamic Botany in Harvard University. *Bulletin No. 13*, Division of Vegetable Physiology and Pathology. U. S. Dept. of Agriculture, Washington, D. C., June, 1898. 8vo, 17 pp., 10 lithographic plates, one colored. Free on application. This latter publication, in particular, should be in the hands of every one who desires to distinguish wholesome from noxious species. To this end a large edition has been issued and the paper has also been included in the yearbook of the Department of Agriculture for 1897.

ERWIN F. SMITH.

Merrill on Lower California.[1] — The attention of botanists who are interested in œcology is called to this paper on account of a number of very interesting plates illustrating the strange vegetation of this peninsula. Very odd and striking are the pictures representing three of the common trees of this region, *viz.*, *Cereus pringlei*, *Fouquiera columnaris*, and *Veatchia cedrocensis*, the latter known as elephant wood. They are desert species which have become profoundly modified to adapt themselves to an adverse climate. Each one illustrates the extreme flexibility of living things, and at the same time speaks volumes regarding their hard, age-long struggle for existence, during which to hoard water every transpiring organ has been thrown away or reduced to the smallest possible compass. Concerning the Fouquiera, which reaches a height of 40 feet and a base diameter of 15 to 18 inches, Professor Merrill says: "A landscape of these pole-like forms, with their thorny branches and few small, brittle, thick, yellow-green leaves is weird in the extreme, and particularly so about dusk. Dry, hot, leafless, noiseless, and apparently lifeless, it conveys vividly to the imagination the idea of a burnt-out world."

ERWIN F. SMITH.

[1] *Notes on the Geology and Natural History of the Peninsula of Lower California.* By George P. Merrill, Curator, Dept. of Geology, U. S. National Museum. Washington, Gov. Printing Office, 1897.

Whitney on Florida.[1] — For the same reason as the preceding we wish to call attention to the plates which accompany this report. They illustrate excellently well some of the peculiar features of the plant associations in Florida. Among these may be mentioned views of (1) high pine land at Ft. Meade, (2) high pine land at Altoona, (3) hammock land at Ft. Meade, (4) border line between scrub and high pine land at Altoona, (5) the characteristic vegetation of the Etonia scrub. Concerning the Etonia scrub, which has been a source of speculation and wonder to every botanist who has seen it, we quote the following :

"The great Etonia scrub formation was examined at Altoona. It is an impressive sight to stand at the border line between the scrub and the high pine land and notice the difference in the character of the vegetation. The high pine land is open, the trees are large and vigorous, and the ground is covered with a crop of grass which gives very good grazing for cattle. The vegetation is quick and generous, and the most tender garden plants will grow luxuriantly if properly attended to. These conditions stop abruptly at the edge of the scrub. The boundary between the high pine land and the scrub can be located without trouble within a few feet. . . .

"In the scrub there is a dense growth of scrub oaks and low bushes and plants, all having thick leaves protected to the utmost from loss of water by evaporation, by the property that desert plants have of turning the leaves up edgeways to the sun, to expose as little surface as possible to the direct rays. No grass is found, and only the most hardy desert plants grow. When pines grow it is the dwarf spruce pine and not the long-leaf pine, while on the other hand the spruce pine is not found across the border in the high pine lands proper.

"The full-grown scrub vegetation reaches about the height of a man's head. . . . This scrub growth stretches out at this place in an unbroken line for ten or fifteen miles to the northward, and the whole country presents a most desolate appearance. The country is generally rolling in both the high pine land and scrub. There are lakes at which the scrub and the high pine vegetation meet at the water's edge. There is no indication from the topography of the country of any difference in the climate over the two soils. Very few attempts are known to have been made to cultivate the scrub

[1] A Preliminary Report on the Soils of Florida, by Milton Whitney, Chief of Division of Soils. *Bulletin No. 13*, Division of Soils, U. S. Dept. of Agriculture, Washington, Gov. Printing Office, June, 1898.

lands. A few efforts to grow truck and oranges are known to have been failures. It is generally believed that the scrub is colder at night, and that frosts are liable to occur over these areas when they do not occur over the high pine land. There is no apparent reason for this, however, in the topography of the country."

Professor Whitney finds no chemical or physical difference in the soils which would account for the diverse vegetation, and is driven to the conclusion that "the only explanation for the difference in the character of the vegetation is that it is accidental, and that the one kind of crop or the other received a start and simply spread, the two kinds of vegetation not being capable of growing together." This is an explanation which does not explain, and we are not inclined to accept it as a final word.

ERWIN F. SMITH.

Forests of Wisconsin.[1] — Those who are interested in the forestry problems of this country will desire to read this report from cover to cover. It is written by a competent forester. It deals with the past and present forest conditions of the so-called pineries of Wisconsin, *i.e.*, the northern half of the state. It is based on personal explorations and on data furnished by trustworthy lumbermen. To obtain the materials for this report Mr. Roth visited every county in the district, making a careful study of its forest cover. When one considers the infinitude of details involved in such a survey, the wonder is that the author has been able to represent things so clearly. No one can read this report without feeling that the work has been well done, or without wishing that Michigan and other pine-woods states might set on foot similar surveys. Unless something of this kind is done, either by the states or by the general government, we shall never know where we are in the matter of timber supply, or fully realize the necessity of forest care and conservation, until we are brought face to face with a scarcity of timber and all its resultant evils.

This survey shows that of the original 17,000,000 acres of forest in northern Wisconsin, 8,000,000 have been cut over by lumbermen; that 40% of this vast area is practically a desert; and that the remaining 60% is now producing nothing better than firewood. Much of this land is worthless for farming purposes and should be

[1] Forestry Conditions and Interests of Wisconsin. By Filibert Roth, Special Agent, with a discussion by B. E. Fernow, Chief of Division of Forestry. *Bulletin No. 16*, U. S. Dept. of Agriculture, Division of Forestry. Washington, Gov. Printing Office, 1898. 73 pp., 1 map.

reforested. The greater part of it is now owned by lumber firms that have removed all the merchantable lumber and would now be glad to sell it to the state for a merely nominal sum. By properly planting this land and policing it (to prevent forest fires), often merely by keeping out the fires, the state authorities might readily reforest the larger part of it, and thus add greatly to the wealth of the state. The *Bulletin* deals with such topics as topography, soils, climate, drainage, ownership, forest fires, changes on cut-over lands, the outlook, etc. Each of the more important timber trees is considered by itself and there are occasional notes on other vegetation. Since the pine lumber has been cut the country is drying out. This is shown in many ways, *e.g.*, by the disuse of corduroy roads, by the cultivation of former swamps, by the lessened flow in rivers, and finally by the fact that the hemlock spruce, which covers all the eastern, middle, and northeastern part of this great tract, is dying out. Of this species no young forests are coming on, and many of the old trees are dead at the top. This decadence is attributed to the fact that the hemlock has a superficial root-system, and is therefore sensitive to changes in the moisture content of the surface soil. That portion of the report devoted to forest fires and to the very detrimental changes they bring about on cut-over lands is particularly interesting. By neglect to reforest these lands it is estimated that the state of Wisconsin loses annually 800,000,000 feet board measure of merchantable lumber.

ERWIN F. SMITH.

Porter's Translation of the "Bonn" Text-book of Botany. — The first German edition of the *Lehrbuch der Botanik für Hochschulen*, prepared by Prof. Eduard Strasburger and his colleagues Schimper, Noll, and Schenk of the University of Bonn, appeared in 1894. The result of a felicitous coöperation upon the part of four able specialists working in the same laboratories and under the guidance of a master mind, this book immediately took high rank among works upon its subject. It has deservedly received much favorable comment and little adverse criticism. It has passed into its second German edition, and is now so generally known on this side of the Atlantic, as well as in Europe, that it is needless here to comment upon its qualities. The English edition,[1] lately prepared by Dr. H. C. Porter, Assistant Instructor of Botany at the University of Pennsyl-

[1] *A Text-book of Botany.* By Strasburger, Noll, Schenk, and Schimper. Translated from the German by H. C. Porter. Published by the Macmillan Co., London and New York, 1898. Price, $4.50.

vania, shows abundant evidence of care and discrimination in its execution. The task of translation has evidently involved no small difficulty. There is no doubt that the German technical vocabulary in botany, partly from the greater plasticity and power of combination in the language itself, partly from the patience and discrimination of the German investigators, has developed a considerable number of apt and valuable descriptive terms which are without exact or generally recognized equivalents in the English. The precise German terminology for the varied structures which in English are loosely termed "bracts" furnishes a case in point. In most instances Dr. Porter's selection of terms seems excellent. Occasional renderings, such as *haulm* instead of the more general *culm*, for the German *Halm*, appear less fortunate. The phrasing of the translation is good, being exceptionally free from labored constructions and foreign idioms. One unfortunate change from the original German edition is the failure to indicate the limits of the individual authorship. This cannot, we believe, be too clearly shown in all joint productions. Professional botanists who are acquainted with the tastes and special pursuits of the Bonn staff, may not need to be told that anatomy or inner morphology was treated by Strasburger, physiology by Noll, general morphology of the cryptogams by Schenk, and of the phanerogams by Schimper, but the ordinary student using an English edition of the text-book will scarcely grasp by intuition the interesting details of this coöperative plan. The print and general make-up of the translated edition are eminently satisfactory, although the small colored illustrations — presumably introduced at first for commercial rather than scientific or esthetic reasons — are not so carefully executed as in the original German edition.

B. L. R.

Catalogo de Plantas Mexicanas (Fanerógamas).[1] — Dr. Urbina, the botanical director of the Mexican National Museum, has recently issued a large octavo of nearly 500 pages, enumerating about 3000 species of Mexican phanerogams. Authorities are duly cited and to some extent bibliography is given. Such *exsiccati* are enumerated as are represented in the herbarium of the Museo Nacional, comprising chiefly the collections of Peñafiel in Hidalgo, Schaffner in San Luis Potosi, Bárcena in Jalisco, Urbina in the Valley of Mexico, and Pringle in various states of the republic. Numbers, localities, and dates of collection are also entered. The catalogue reflects credit

[1] Collated by Dr. Manuel Urbina, and published by the Museo Nacional, City of Mexico.

upon the energy and industry of Dr. Urbina, and is unquestionably the best production of its kind which has issued from Mexico. It will doubtless stimulate local interest among Mexican botanists, but for several reasons can assist but little the foreign students of the Mexican flora. It is far from being a complete enumeration of the known species of the country, and its extent is determined neither by geographic boundaries nor by the limits of natural orders, but rather by chance, since, as it appears, only such species are mentioned as happen already to be represented in the Museo Nacional. A valuable feature of the catalogue is the introduction of a considerable number of local vernacular plant names which, now that they are coupled with their Latin equivalents, may well give clues to the real identity of various Mexican drugs and officinal plants which reach our museums in no condition for botanical determination. B. L. R.

Recent Contributions to Morphology of the Higher Plants.[1] — The high standing of Professor Goebel and his many important contributions to the morphology of the higher plants makes the present work of great interest to botanical students everywhere. The volume at hand is the first of a series which promises to give a comprehensive summary of what may, perhaps, be termed "developmental morphology," which seems to be about what Goebel means by Organography.

This first volume deals with general Organography, or a general consideration of the members which make up the vegetable organism, their origin and modifications. In the preface attention is called to the great changes which have taken place in regard to morphological questions. The old idealistic conception of "morphologically equivalent" organs as structures which are patterned after an imaginary "type" has been replaced by the idea of homologous structures which are really genetically related. Goebel also insists, and very justly, that no sound system of morphology can be based upon the use of a single character, but that all factors must be taken into account; and, as has already been pointed out by him in his previous studies, the impossibility of divorcing absolutely morphology and physiology is here emphasized. In his zeal as to the importance of determining the causes which directly influence plants as they at present exist, he is perhaps a little too severe on those botanists who

[1] *Organographie der Pflanzen, Erster Teil, Allgemeine Organographie.* Dr. K. Goebel, Professor of Botany in the University of Munich. Jena, Gustav Fischer, 1898.

yield to the fascination of phylogenetic studies. When, for example, he says, "It seems to me that the recognition of the factors which make one side of a leaf larger than the other is of more importance than the building up of a phylogenetic structure from unsupported hypotheses," there is an implication of the futility of *all* phylogenetic speculation which we feel is scarcely warranted.

While the first section of the book ("Allgemeine Gliederung des Pflanzenkörpers") takes into account the morphology of the Thallophytes, the rest of the work is confined to a discussion of the Archegoniates and Spermatophytes. The question of the province of morphology is treated at length, and very clearly, in the first section. The impossibility of clearly separating structure and function is emphasized, and the difficulties in absolutely distinguishing homologies and analogies are pointed out. As he very clearly shows, it is perfectly evident that the same result has been brought about in much the same way in widely divergent stocks. For instance, while the leaves of such an anacrogynous liverwort as Fossombronia, and those of an acrogynous form like Jungermannia are doubtless homologous in the sense that they bear the same relation to the apical cell of the shoot, nevertheless there is every reason to believe that they have developed quite independently of each other.

In classifying the fundamental organs of plants, Goebel divides them first into two categories, vegetative and reproductive organs. In view of the difficulties of limiting the definitions of stem (caulome) and leaf (phyllome) in the vascular plants, our author regards these as modifications of a common fundamental structure, the shoot (Spross), while the root is the second of the two primary vegetative structures. Hairs (trichomes) and "emergences" are considered as appendages merely of the two fundamental structures. While, of course, the stem and leaves of the higher seaweeds and mosses are recognized as not being the homologues of those of the vascular plants, still Goebel does not think it best to adopt new names for these structures.

The second group of fundamental structures, the reproductive organs, are of two kinds, sporangia (or sporogonia) and sexual organs, antheridia and archegonia (or oögonia). Goebel was perhaps the first botanist to show that the sporangia of the ferns, for instance, are in no proper sense to be considered as modifications of structures once vegetative in nature, but that they, as well as the sexual organs, must be considered as fundamental structural types. The whole trend of the conclusions, based upon the most recent study of the

archegoniates, is that the sporogenous structures of the sporophyte are older than the vegetative ones.

The discussion of the division of labor and development of special organs in the Thallophytes is treated clearly and interestingly, but offers nothing especially new.

The section dealing with the question of cohesion and reduction of parts is clearly presented, and Goebel, like most students who have made a practical study of developmental morphology, recognizes the absurdity of assuming that all simple flowers such as many apetalous Dicotyledons and the lower Monocotyledons like the Araceæ and Naiadaceæ are necessarily reduced from some forms with more complex flowers — a relic of the old metaphysical notion of a "typical flower" to which all other types must be made to conform.

The second division of the volume deals with the question of symmetry in the plant-body. It is treated at length and the author brings up many interesting points, especially those dealing with the causes and significance of bilaterality or dorsi-ventral symmetry in shoots and leaves, as well as zygomorphy in flowers. In regard to the latter point, he concludes that we are not much nearer to understanding the mechanism by which they have been produced than were Sprengel and De Candolle. All we know is that they are in most cases associated with cross-fertilization, and that zygomorphic flowers are always lateral in origin.

The most interesting part of the book is the portion dealing with the changes in the character of the organs of the plant, especially the leaves, as the plant develops from its earlier stages to maturity. Goebel has already published several very important contributions to this most interesting subject, but he adds here a good deal that has not before appeared, and at the same time includes a summary of the more important results of his earlier investigations, especially with regard to the changes in the form of leaves and the significance of these early leaf-forms. Perhaps the most important of the new types brought forward here is that of certain tropical Aroids, especially some of the climbing forms. These striking plants are very conspicuous in the American tropics. Goebel made a special study of some of these and found that in their earlier stages of growth they had simple, sessile leaves, closely overlapping and completely concealing the stem. The flowering shoots, however, lose the dorsi-ventral character, and the much larger and often variously cut leaves, *e.g.*, Philodendron, are borne upon long petioles. It appears that

these immature forms have been propagated in greenhouses under various names, "Pothos," "Marcgravia,"— very much as the early shoots of Thuja, with the needle-shaped leaves, were for so long supposed to belong to a special genus, Retinospora.

The reversion to the primitive leaf-forms in the seedlings and sometimes in older shoots of various water-plants and xerophytes is discussed at length, and their bearing upon the questions of the origin and affinities of these plants is admirably set forth.

The fourth division of the work deals with malformations of various kinds, discussing in a very suggestive way their cause and significance. Goebel believes that the explanation of Sachs, who assumes that specific chemical substances are developed which determine the character of the various organs, is the most plausible one yet brought forward. Goebel's explanation of the reason why malformations, especially the transformation of one organ into another, are so much commoner in the flowers than in the other organs of the plant, *e.g.*, the roots, is because the young organs of the flower are formed in rapid succession, and close together, so that the specific substances properly belonging to one organ are more likely to reach one of another kind, thus producing a more or less transitional form. To quote from our author: "If, for instance, molecules of such substances as induce anther-formation should stray even by the thousandth part of a millimeter from their path, or should be checked or hastened in their transportation to the growing point of the flower, there would thus result a more or less complete transformation of the petals or carpels into stamens."

Goebel also quotes from Sachs to show that the latter conceives these "blütenbildende" substances to have somewhat the character of ferments, an extremely small quantity having power to affect large masses of plastic substance. A similar character is attributed by Beyerinck to what he calls "growth enzymes," produced by gall-forming insects, which so affect the protoplasm of the host-plant as to give rise to the specific gall-form.

While these theories are certainly interesting and not improbable, they seem quite as difficult to prove as the phylogenetic hypotheses, which Goebel in another part of his work seems to think so hopeless.

The last division of the book has to do with the influence of correlation and external stimuli upon the form of the vegetable organism, and presents many interesting details which cannot here be discussed at length.

Every botanist who is interested in morphological problems must

feel grateful to Professor Goebel for the admirable manner in which he has presented them, and all will look forward eagerly to the appearance of the subsequent volumes, which we hope may not be long delayed.

DOUGLAS HOUGHTON CAMPBELL.

STANFORD UNIVERSITY,
May, 1898.

MINERALOGY.

Genesis of the Diamond.— Derby[1] has sifted the evidence of the Brazilian deposits bearing on the puzzling and as yet unsolved problem of the origin of the diamond. Three localities are discussed, of as many types.

At the Agua Suja mine, in western Minas Geraes, the diamond-bearing bed is a decomposed conglomerate, both matrix and pebbles having been transformed into clay. The fragments can, however, still be recognized as belonging to the various schists, granites, and sandstones upon which the bed rests, and to basic eruptives, probably members of the nepheline-bearing series of rocks of the region. Weight is placed upon these basic eruptives as suggesting an analogy with the South African deposits; on the whole, however, the differences are more striking than the similarities. The diamond is evidently contained in the cement, not in any constituent of the breccia, and its source cannot even be conjectured with any degree of certainty.

In the mines of Diamantina and those of Grao Mogõl, all in Minas Geraes, which are the oldest and best known of the Brazilian fields, the diamonds occur in a quartzose rock known as itacolumite. There are two types of this rock, a schistose form, and a massive variety which the writer believes is clearly clastic, and later than the schistose form, resting unconformably upon it. Probably both types of the rock are clastic, but both are largely metamorphosed, and it is impossible to say whether the diamond is a local product of that metamorphism or was introduced as a clastic element.

The third locality described is the mine at São João Chapada, near Diamantina. The description is very full, the place having never been described before, as its interest demands. It consists of a huge open pit, in a mass of clay produced by the complete decomposition of the country rocks. The clays may be differentiated

[1] Brazilian Evidence on the Genesis of the Diamond. *Journ. of Geol.*, vol. vi, p. 121.

roughly by variety of color into three horizons, or rather bodies, as their shape is irregular, in each of which diamonds are said to have been found. A careful consideration of the materials of these various clays leads the author to consider that they represent an original group of phyllites of varied character, but chiefly of clastic origin, threaded with veins of pegmatite, and possibly containing some eruptive material of more basic character. Assuming the correctness of this analysis of this very obscure and difficult problem of "mud-geology," it becomes desirable to know, first, whether the pegmatite was eruptive and may have exercised a metamorphic action upon the schists, or was secretionary; second, whether the diamond belongs to the pegmatite or to the country rock. The first question the writer decides in favor of the eruptive hypothesis, although the evidence is not conclusive. The second he considers it necessary to leave an open one, but the indications seem to favor the view that the diamonds were formed in the phyllites on the border of the pegmatites and presumptively through the agency of their eruptive action, the phyllites having provided the carbon which is shown to be amply sufficient.

Etching Figures of Triclinic Minerals.[1] The writer has investigated several triclinic minerals by the etching method for the purpose of determining whether they possessed the holohedral centre-symmetry of that system. His experiments on tourmaline (hexagonal, hemimorphic) and on cleavage plates of acid dextro-tartrate of strontium (triclinic, hemihedral) showed that the etching figures produced on two parallel crystal faces of unlike physical character were distinctly different, sufficiently so to be used as a safe means of determining such unlikeness. The tests recorded were made upon the following minerals, the result in all cases being confirmatory of their accepted holohedral character: axinite, cyanite, copper sulphate (artificial crystals), rhodonite, albite. On the tourmaline and cyanite the etching was produced by the action of a fusing mixture of acid potassium sulphate and fluorite, on the others by a mixture of equal portions of sulphuric and hydrofluoric acids. The results add to our knowledge of the etching figures of some of the minerals named, although negative as far as concerns the point investigated.

Clinohedrite, a New Mineral from Franklin, N. J.[2] — The new mineral was first found by Mr. Nason some two years ago, but more

[1] Walker, T. L. *Amer. Journ. of Sci.*, vol. v, p. 176, 1898.

[2] Penfield, S. L., and Foote, H. W. *Amer. Journ. of Sci.*, vol. clv, p. 289, 1898.

recent finds of better material have first made a complete description possible. But few specimens in all have yet been found, all coming from the Trotter mine, at a supposed depth of about one thousand feet. It is associated with willemite, massive brown garnet, phlogopite, axinite in small crystals, datolite, and a reddish-brown mineral occurring in slender prismatic crystals, whose investigation is not yet complete, but which proves to be a new silicate containing lead, iron, and calcium as essential constituents.

The name of the new mineral, clinohedrite, is suggested by the prevalence of forms having no parallel faces. It is monoclinic in crystallization, and of special interest as belonging to the hemihedral division of that system, the "domatische klasse" of Groth, hitherto represented among mineral substances only by occasional crystals of pyroxene, which, however, seems to be normally holohedral. The crystals were well suited to measurement, upwards of 4 mm. in greatest dimension, and of two types.

The axial ratio is as follows: $a:b:c = 0.6826:1:0.3226$, $\beta = 76° 4'$.

Forms observed:

b, 010	n, 120	p, 111	r, $\bar{3}31$	o, $\bar{1}31$
h, 320	l, 130	p_1, $\bar{1}1\bar{1}$	s, $\bar{5}51$	o_1, $13\bar{1}$
m, 110	e, 101	q, $\bar{1}11$	t, $\bar{7}71$	x, $\bar{1}3\bar{1}$
m_1, $\bar{1}10$	e_1, $\bar{1}0\bar{1}$	q_1, $11\bar{1}$	u, $\bar{5}31$	y, $\bar{1}2\bar{1}$

Cleavage perfect parallel to b, 010, hardness 5.5, specific gravity 3.33.

Many crystals are transparent, the color varying from amethystine to colorless or white. Double refraction negative and not very strong. Plane of optic axes at right angles to 010; the crystallographic axis b, the acute bisectrix. Exhibits distinctly the phenomena of pyro-electricity, the faces p, e and upper extremities of m becoming, on cooling, positively electrified, the diagonally opposite faces, x, y, p, e, negatively. Chemical composition:

SiO_2	ZnO	MnO	CaO	MgO	H_2O	$(Fe.Al)_2O_3$	Sum
27.22	37.44	0.50	26.25	0.07	8.53	0.28	100.32

corresponding to the formula $H_2Zn\,Ca\,SiO_5$ or $(ZnOH)\,(CaOH)\,SiO_3$, analogous to that of calamine $(ZnOH)_2\,SiO_3$.

Pyrognostics: in closed tube, unchanged at low heat, at faint redness exfoliates, whitens, and gives off water. Fuses at 4 to a yellowish enamel. Soluble with gelatinization in HCl.

Rhodolite, a New Variety of Garnet.[1] — Under this name a variety of garnet is described which occurs in placer deposits in Macon County, North Carolina, and is notable for its fine amethystine and rose color, and gem quality of clearness. It occurs only in rolled or etched fragments, together with the following minerals, in more or less abundance: quartz, pyrope, corundum, spinel, iolite, cyanite, fibrolite, hornblende, staurolite, rutile, chromite, monazite, zircon, gold, sperrylite, menaccanite, and bronzite.

The specific gravity of the material which was very free from inclusions was 3.838. Chemical composition:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Sum
41.59	23.13	1.90	15.55	17.23	0.92	100.32

corresponding to the formula $2Mg_3Al_2(SiO_4)_3.Fe_3Al_2(SiO_4)_3$, a mixture of two pyrope molecules with one of almandine.

PETROGRAPHY.

Classification of Igneous Rocks. — In an interesting paper on the relation between the chemical and mineral composition of igneous rocks, Iddings[2] shows very plainly that the mineral composition of a cooling magma is dependent both on the original composition of this magma and upon the character of the minerals that *first* separate from it. It is well known that quartz is usually associative only with the polysilicate-feldspathic minerals. Of these minerals the most acid one possible with the available silica in the magma, is that which forms first. The alkalies seem to control an equal amount of alumina, forming alkali-feldspathic molecules, the alumina in excess combining with calcium to form anorthite, or with magnesium and iron to produce the amphiboloids. These and several other laws less firmly established have been carefully worked out by comparing the mass composition of massive rocks with their mineral composition. The author discusses in detail the mineral composition of magmas (1) in which the alkali is wholly soda and in which alumina is present in equivalent quantities with the soda; (2) those in which the sole alkali is potash with alumina in equal quantity; and (3) those in which the alkalies control an equal amount of alumina and in which lime and additional alumina occur in the proportion of

[1] Hidden, W. E., and Pratt, J. H. *Amer. Journ. of Sci.*, vol. clv, p. 294, 1898.
[2] *Journ. of Geol.*, vol. vi, p. 219.

1 to 1. The results of the investigations are exhibited in several diagrams, which show in a remarkable manner the relations between the chemical and the mineral composition of a large number of rocks.

California. — Massive flows of a rock intermediate in composition between trachytes and andesites are associated with the andesitic tuffs and breccias in the Sonora and Big Trees quadrangles of the Sierra Nevada, California. The rocks, according to Ransome,[1] are characterized by a high percentage of alkalies with potash in excess of soda. The author describes them under the name latite, possessing large phenocrysts of plagioclase and a few anhedra of pale-green augite in a compact aphanitic base. Under the microscope idiomorphic olivines are also discovered. The groundmass is a hyalopilitic aggregate of labradorite, augite, and a globulitic glass, magnetite, and apatite. Biotite phenocrysts are present in some specimens. The fact that the analyses of all specimens show the presence of considerable potash, while at the same time no potash-bearing mineral has been observed in them, suggests that the residual glass is very rich in this oxide. Analyses of the augite-latite from Tuolumne, Table Mt., and of the biotite-augite-latite from near Clover Meadow follow:

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	H_2O	P_2O_5
Aug.-latite	56.19	.64	16.76	3.05	4.18	3.79	6.53	2.53	4.46	1.00	.55
Biot.-au.-latite	62.33	1.05	17.35	2.98	1.63	1.05	3.23	4.21	4.46	1.19	.29

besides small quantities of MnO, BaO, SO_2, Li_2O, and C.

These rocks are the effusive equivalents of the monzonites. They differ from andesites in possessing a large percentage of the alkalies with potash predominating. They differ from trachytes in containing no sanidine. They are closely related to the vulsinites, ciminites, and other rock types described abroad. The term latite is proposed to include all the effusive forms of monzonite, leaving vulsinite, ciminite, etc., as terms for varietal forms. It is nearly equivalent to Washington's term trachy-dolerite. The dike rocks corresponding to the latites may be the banakites of Iddings.

Nodular Granite, Ontario. — A peculiar occurrence of nodular granite has been found by Adams[2] in the township of Cardiff, Peterborough County, Ontario. The granite is a fine-grained reddish rock banded by streaks of different degrees of coarseness. The nodules are spherical or elliptical, with diameters varying from one

[1] *Amer. Journ. of Sci.*, vol. v, p. 355, 1898.
[2] *Bull. Geol. Soc. Amer.*, vol. ix, p. 163.

to eight inches. Their nuclei are usually lighter in color than their peripheral portions, and contain often little bunches of tourmaline and plates of muscovite. In some places the nodules are arranged in rows. Sometimes the nodules of a row coalesce and pass into a continuous band with all the properties of a vein. Through the veins are scattered bunches of tourmaline, like those in the centers of the nodules; and the central portion of the vein, like the nuclei of the nodules, is composed of feldspar and muscovite. Its periphery, like the peripheries of the nodules, consists principally of quartz and sillimanite. Analyses of the granite (I) and the nodules (II) show the latter to be the more siliceous and the less alkaline.

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Loss	Total
I	78.83	10.88	1.63	.22	.35	5.31	2.13	.32	= 99.67
II	81.43	13.70	1.58	.37	.06	1.28	1.02	.92	= 100.36

From a consideration of the manner of occurrences of the nodules and their composition when compared with the granite, Adams concludes that they were derived from the crystallization of a magma which was free to gather itself into rounded drop-like forms which the isolated portions of such a liquid would take, but which could not be developed in a magma when crystallization was far advanced.

The rock of the Great Whin Sill in Durham and Northumberland has profoundly altered the carboniferous limestones, shales, and sandstones with which it is in contact. Hutchings[1] declares that the pure limestones have simply suffered crystallization except in the immediate contact with the eruptive where garnets have sometimes been produced. The eruptive, on the other hand, has had developed in it both small garnets and small flakes of a brown biotite. Argillaceous limestones have suffered a great deal more change than the purer limestones. The new contact minerals found in them are garnet, augite, idocrase, wollastonite, epidote, hornblende, feldspar, chlorite, and sphene. The shales have become indurated. Chlorite and muscovite have been formed in large quantity and "spots" have developed. In many of the shales, especially sandy varieties, much of the quartz has recrystallized, feldspar has been produced, and the characteristic contact minerals, andalusite, biotite, anthophyllite, etc., have originated. The calcareous shales are the most intensely altered of all the beds in the district. They yield a hornfels filled with garnets, idocrase, spinel, wollastonite, and, in short, all the other minerals characteristic of the altered argillaceous limestones and the shales.

[1] *Geol. Magazine*, vol. v, pp. 69, 123, 1898.

After discussing a large number of analyses of the altered and the unaltered rocks, the author concludes that it cannot be proved that transfer of soda from the igneous rock to the sedimentary ones has taken place. The paper closes with a protest against ascribing to dynamic-metamorphism many of the effects that may be due to contact action.

Notes. — The "porphyritic gneiss" of New Hampshire, formerly supposed by Hitchcock and others to be a Laurentian metamorphosed sediment, is shown by Daly[1] to be an igneous rock intruded into the surrounding rocks in post-Devonian time. Iwasaki[2] mentions the existence of a diorite dike cutting the Tertiary rocks in the Usui Pass, near Tokio, Japan. It consists of zonal plagioclase, hornblende, quartz, and several accessory and secondary constituents. The author calls it an andendiorite, following Stelzner, who has described a quartz-bearing mica diorite occurring in a "neovolcanic dike" in Argentine.

Two interesting examples of contact action are described by D'Achiardi.[3] The first is between dolomite, on the one hand, and granite and diabase on the other, near Berdiaouch in the Ilmen Mountains, Russia, and the second between limestone and granite on the Isle of Elba. The new minerals produced in the limestones by the contact action are not essentially different from those occurring under similar conditions elsewhere. The development of antigorite, pyroxene, wollastonite, and white mica is especially prominent.

W. S. Bayley.

[1] *Journ. of Geol.*, vol. v, pp. 694, 776. [2] *Ib.*, vol. v, p. 821.
[3] Atti della Soc. Tosc. d. Sci. Nat. Pisa. *Memoire*, vol. xvi.

SCIENTIFIC NEWS.

THE University of St. Andrews, Scotland, is to establish professorships of physiology, anthropology, and anatomy.

The Botanical Club of Barnard College has transferred $500 to the college as the nucleus of a fund for the equipment of a botanical laboratory to be named in memory of the late Prof. Emily L. Gregory.

The College of Physicians of Philadelphia announces the first Hatfield prize competition. The subject is "A pathological and clinical study of the thymus gland and its relations." Competing essays must be in the hands of the committee on or before Jan. 1, 1900.

The *Journal of the Marine Biological Association*, England, contains in its April number a description of an apparatus for keeping medusæ alive in the aquarium. It was found that medusæ, to live, must float at the surface, and in ordinary aquaria they can only do this by constant pulsations of the umbrella. This severe and constant strain resulted in physical exhaustion and death. The apparatus consists of an automatic plunger which creates currents in the water, and by its aid specimens were kept alive for six weeks.

Mr. N. B. Harrington and Mr. Reid Hunt, of Columbia University, have gone to the west coast of Africa in the hope of obtaining material upon the embryology of Polypterus, one of the two existing corsopterygian ganoids, and one of the most interesting of vertebrates, since by many — Pollard, Cope, Kingsley, Dollo, and others — they are regarded as being the nearest to the ancestors of Amphibia and hence of the aminotes. The expedition has received $1800 from Mr. Charles F. Senf.

Prof. C. L. Bristol, of New York University, goes with a party of students to the Bermudas, where he spent last year. It is proposed to erect a permanent station there, but probably not this year.

An important step is probably to be taken in London in the removal of the collections of the geological survey from their crowded quarters in Jermyn Street to South Kensington.

At last the University of Oxford is to have a respectable morphological laboratory. Prof. E. Ray Lankester was appointed to the university in 1891, and during these years his work has largely been conducted in a small one-story building constructed of corrugated iron, affording quarters far inferior to those in the average American college. The university is now to expend not more than $35,000 in removing the old building and in erecting on its site a laboratory and a lecture room for the chairs of botany and comparative anatomy.

The Russian Society of Naturalists and Physicians holds its tenth congress at Kieff from August 21 to August 30.

Money is being collected for a monument to the memory of the late Baron Ferdinand von Müller, who did so much for Australian natural history.

The Imperial Museum of Japan has just issued a preliminary catalogue of the collection of fishes *sensu latior* in its possession. The catalogue is compiled by Dr. Ischikawa and Mr. Matsuura, and enumerates 1076 specimens. The localities for each are given in Japanese except for those coming from extra-Japonic waters. The collection is almost exclusively Japanese, *Balistes vetula*, *Anicurus nebulosus*, and *Lepidosteus osseus* being the only American representatives. No specimens of Chlamydoselachus are catalogued, nor are there any Japanese species of Amphioxus included, although Nakagawu has recently described a form from Japanese waters.

The fresh-water sponges *Ephydatia obusta* and *Carterius tubisperma* described by Edward Potts from American waters have just been found by Garbini in the Garda Sea of Northern Italy.

The following information reaches us concerning the Geological and Natural History Survey of Wisconsin: Mr. Weidman is now in the field, completing the field work on an area of the older rocks in the vicinity of Wausau and Merrill, in the northern part of the state. This work will be continued during the summer. Mr. Buckley has been at work at a large report upon the building-stone industry of the state. This will probably be ready for the printer during the summer.

The following work is planned for the season: Prof. R. D. Salisbury, of Chicago University, and an assistant, will complete the work necessary to the preparation of a bulletin on the physical geography

and geology of the region about Devil's Lake and the dells of the Wisconsin River. Prof. G. L. Collie, of Beloit, will complete the preparation of a general account of the physical geography of southern Wisconsin, the field work for which was nearly completed last season. Prof. D. P. Nicholson will work at physical geography, probably in the northern part of the state. Prof. L. S. Cheney is preparing a popular report on the forest trees of the state. Prof. E. A. Birge, of the State University, and Prof. C. D. Marsh intend to carry on their studies of the plankton of the lakes in the central and southern parts of the state. The Survey has two bulletins in type : one by Filibert Roth, of the United States Department of Agriculture, upon the forest conditions of the state, and one by Dr. and Mrs. G. W. Peckham, on the habits and instincts of the solitary wasps. Mr. S. Weidman has ready for publication a bulletin on certain volcanic rocks in the Fox River Valley.

The following appointments to fellowships are announced: at Columbia University, botany, E. Hagen; geology, J. D. Irving; zoölogy, F. C. Paulmier; psychology, R. S. Woodworth. At Johns Hopkins University: physiology, P. M. Dawson; geology, L. C. Glenn; zoölogy, G. O. James. Tufts College : biology, S. P. Capen.

The last annual report of the British Museum shows that the number of visitors to the Natural History Museum during 1896 was 417,033 on week days and 36,923 on Sundays, making a total of 453,956 as compared with 446,737 (on week days only) in the year 1895. The average attendance for all open days, including Sundays, during the year was 1316 ; that for week days only, 1336, as compared with 1436 in 1895, thus making the average week-day attendance 150 less in 1896 than in 1895. The museum was opened for the first time on Sunday, on May 17, 1896, and the figures would seem to indicate that after the inauguration of the Sunday openings, daily, at least 100 visits were postponed until Sundays; and that owing to the Sunday opening, there was, in little more than half a year, a net gain of 7219 visitors to the museum.

Recent appointments : B. M. Duggar, instructor in botany in Cornell University. — Dr. J. E. Durand, reappointed instructor in botany in Cornell University. — Dr. Fischer, docent in anatomy in the German University at Prague. — W. J. Gies, instructor in physiology at Yale. — E. S. Goodrich, demonstrator of anatomy in Oxford University. — Dr. Karl Hischeler, private docent in zoölogy

in the University of Zurich. — Professor Kalkowsky, director of the Mineralogical, Geological, and Ethnological Museum at Dresden. — Gräfin Maria von Linden, second assistant in zoölogy in the University of Tübingen. — Dr. William Pollard, assistant petrologist of the Geological Survey of Great Britain, at Jermyn Street, London. — H. J. Seymour, assistant petrologist of the Geological Survey of Great Britain, at Dublin. — Prof. Herbert Osborn, formerly of the Iowa Agricultural College, has been appointed to the chair of zoölogy at Ohio State University, left vacant by the death of Professor Kellicott. — Dr. C. O. Townsend, formerly instructor in botany at Barnard College, has recently been elected botanist and plant pathologist for the state of Maryland. — C. B. Wedd, assistant geologist of the Geological Survey of Great Britain. — K. M. Wiegand, assistant in botany in Cornell University. — Dr. E. Zacharias, director of the Botanical Gardens at Hamburg.

Recent deaths: Maurice Hovelacque, secretary of the Geological Society of Paris. — Dr. C. Herbert Hurst, zoölogist, formerly of Owens College, Manchester, and more recently demonstrator in zoölogy in the Royal College of Science, Dublin. — W. C. Lucy, an English geologist, May 11, aged 75. — W. M. Maskell, entomologist in New Zealand. — Prof. Friedrich Müller, ethnologist, of Vienna, May 25, aged 64. — Edward Wilson, curator of the museum at Bristol, England, May 21, aged 49.

PUBLICATIONS RECEIVED.

Biological Lectures Delivered at the Marine Biological Laboratory of Woods Holl. 1896–97. Boston, Ginn & Company. 242 pp., 8vo. Illustrated. $2.15. — DETMERS, W. Practical Plant Physiology. An Introduction to Original Research for Students and Teachers of Natural Science, Medicine, Agriculture, and Forestry. Translated from the second German edition by S. A. Moor. London, Swan Sonnenschein & Co., 1898. xix + 555 pp., 8vo, 184 illustrations. $3.00. — NEEDHAM, JAS. J. Outdoor Studies. A Reading-Book of Nature. American Book Co., 1898. 90 pp., 8vo, 88 figs. — *Report of the Commissioner of Education, 1896–97.* Vol. i, Pt. i. Washington, 1898. 1136 pp., 8vo. — SARS, J. O. An Account of the Crustacea of Norway. Vol. ii. Isopoda. Pts. ix, x. Munnopsidæ (concluded), Ligiidæ, Trichoniscidæ, Oniscidæ. Bergen, The Bergen Museum, 1898. Pp. 145–184, Pls. 66–88.

Botanical Gazette. Vol. xxv, No. 6, June. — *Current Thought.* New series, Vol. i, No. 3, July. — *Geological and Natural History Survey of Minnesota.* Second series, Pt. i, June. Minnesota Botanical Studies. — *Verhandlungen der russisch-kaiserlichen mineralogischen Gesellschaft zu St. Petersburg.* Zweite serie, Bd. xxxiv, Lief. ii, 1896. Bd. xxxv, Lief. i, 1897. — *Materialen zur Geologie Russlands.* Herausgegeben v. d. kaiserlichen mineralogischen Gesellschaft. Bd. xviii, 1897. — *Verhandlungen der kaiserlichen mineralogischen Gesellschaft zu St. Petersburg.* Systematisches Sach- und Namen-Register z. d. zweiten Serie d. Verhandlungen u. den Materialen zur Geologie Russlands. 1898. — *Knowledge.* Vol. xxi, No. 153, July. — *Michigan State Agricultural College Experiment Station.* Bulletins 157, 158, Hog Cholera and Some Experiments with Poultry. May. Elementary Science Bulletin No. 4. Observations on the Leaves of Clovers at Different Times of Day, by J. J. W. Beal. May. — *Naturen.* Aarg. 22, No. 5, May. Bergen, John Grieg. — *North Carolina Agricultural Experiment Station.* Bulletins 147 and 148, June, 1898. A Study of Lettuces, by W. F. Massey; Digestion Experiments, by F. E. Emery and B. W. Kilgore; Pasteurization of Milk, by F. E. Emery. — *Proceedings Natural Association of Staten Island.* Vol. vi, No. 8, June. — *Société Scientifique du Chili.* Actes, Tome vii (1897), Liv. 5. Santiago, April, 1898. — *The Zoölogist.* Fourth series, Vol. ii, No. 18, June.

(Number 379 was mailed July 30.)